US 206

datron

OPERATING MANUAL

DATRON MODEL 1041

DIGITAL VOLTMETER

METEOR CLOSE

NORWICH AIRPORT INDUSTRIAL ESTATE NORWICH NR6 6HQ ENGLAND

OPERATING MANUAL

for

DATRON MODEL 1041

DIGITAL VOLTMETER

Instrument Designed and Manufactured by:–

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SECTION 1

INSTALLATION

1.1 UNPACKING AND INSPECTION

Note:

SHOULD YOUR INSTRUMENT HAVE BEEN SUBJECTED TO EXCESSIVE MISHANDLING IN TRANSIT THE FACT WILL PROBABLY BE VISIBLE AS EXTERNAL DAMAGE TO THE SHIPPING CARTON. UNPACK THE INSTRUMENT AND CHECK FOR EXTERNAL DAMAGE TO CASE, PUSHBUTTONS, TERMINALS ETC. IF ANY DAMAGE IS FOUND, NOTIFY THE CARRIER IMMEDIATELY.

Every care is taken in the choice of packaging materials to ensure that your new instrument will reach you in a perfect condition. Our packaging and protection is adequate to cater for all the normal hazards of road or rail transit. Special export packaging is provided for overseas orders.

1.2 INSTALLATION

The Model 1041 is housed in a robust, heavy-gauge aluminium case so designed to withstand the rough knocks of industrial usage. A detachable supply lead, comprising two metres of 3-core P.V.C. sheath cable permanently moulded to a fully-shrouded 3-pin cable socket fits at the rear of the instrument and should be pushed firmly home. Connect the supply lead to a 3-pin plug (fused 1 amp), ensure that the instrument case is earthed via the Yellow/Green earthing wire.

1.2.1 Voltage Tappings

The instrument is packed ready for use with 210V to 255V, 48 to 440 Hz supplies, unless otherwise specified at the time or ordering. For operation from supplies in the range 100V to 128V, 48 to 440 Hz, it is necessary to alter the connections to the primary windings of the mains trnasformer. Remove the top cover and note the tags mounted on the printed circuit board adjacent to TR1 (Refer to Drawing No. 409120A).

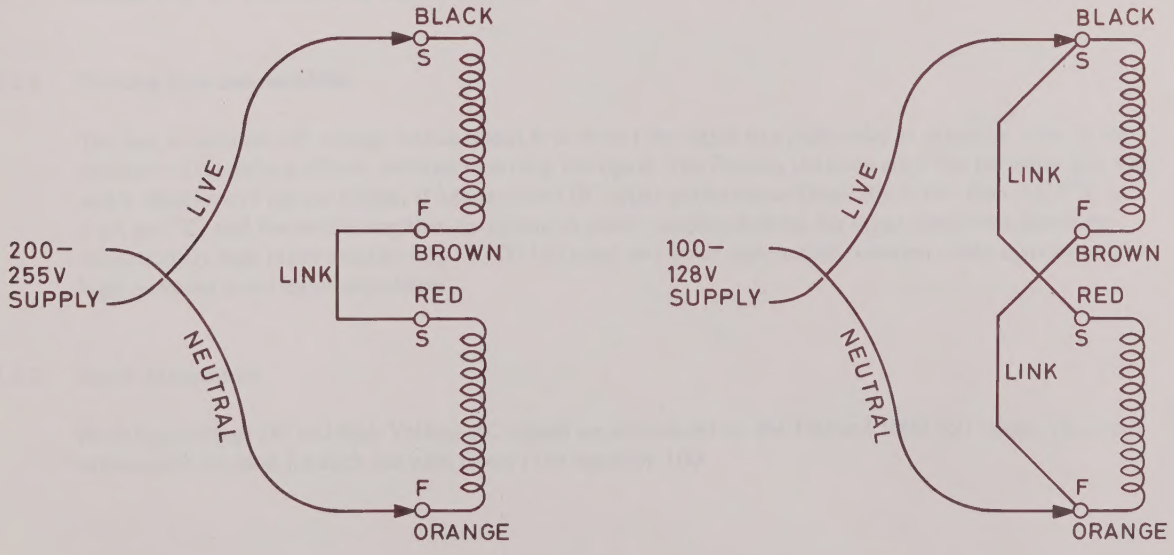


FIG. 1:1 Mains transformer tappings

SECTION 2

GENERAL DESCRIPTION AND SPECIFICATION

2.1 FEATURES

The Model 1041 Multi-function digital voltmeter is a high precision measuring instrument featuring exceptionally high stability and full systems capability. The main frame, providing full D.C. measurement capability, can accept one of two available true RMS AC converters and a 4-wire resistance measurement converter providing an economical solution to most high precision measurement problems.

2.1.1 Options

O1	Very high precision 6 range true RMS converter.
11	Medium accuracy 4 range true RMS converter.
O2	Resistance converter providing guarded 4-wire measurements from –001Ω resolution to 19·999 MΩ.
PO1	Electrically isolated remote programming.
BO1	Electrically isolated BCD output.
BO2	Electrically isolated 3-state BCD output.
RO1	Rear input via a 7-way connector wired in parallel with the front panel terminals.
RO2	External reference, a 4-wire reference input connector mounted on the rear panel to provide ratio measurement capability.

2.2 ELECTRICAL DESCRIPTION

The instrument comprises a precision fully floating isolation amplifier with electronically switched gain ranges providing a 1 volt full range output via its output buffer which is converted to a digital reading by the analogue to digital converter. Three main options are available, the true RMS AC converters which converts AC signals to DC and applies the DC to the DC output buffer. The resistance converter passes a known precision current through an unknown resistance and the voltage generated is thus sensed by the isolation amplifier. Ratio measurements are made possible by replacing the precision internal reference with an externally generated voltage. Fig. 2.1 illustrates the various sections.

2.2.1 Floating Isolation Amplifier

The key to accurate DC voltage measurement is to detect the signal to a high order of precision, even in the presence of disturbing effects, without upsetting the signal. The floating isolation amplifier performs this task and is therefore of unique design. It has excellent DC offset performance (typically better than ·1μV/°C and 1 pA per °C) and the whole amplifier, including its power supplies follows the input signal thus providing exceptionally high input resistance (>10,000 MΩ) and very good rejection of common mode signals due to its high common mode input impedance.

2.2.2 Input Attenuators

Both high voltage DC and high Voltage AC signals are attenuated on the 100 and 1000 volt ranges. Different attenuators are used for each but each divides the signal by 100.

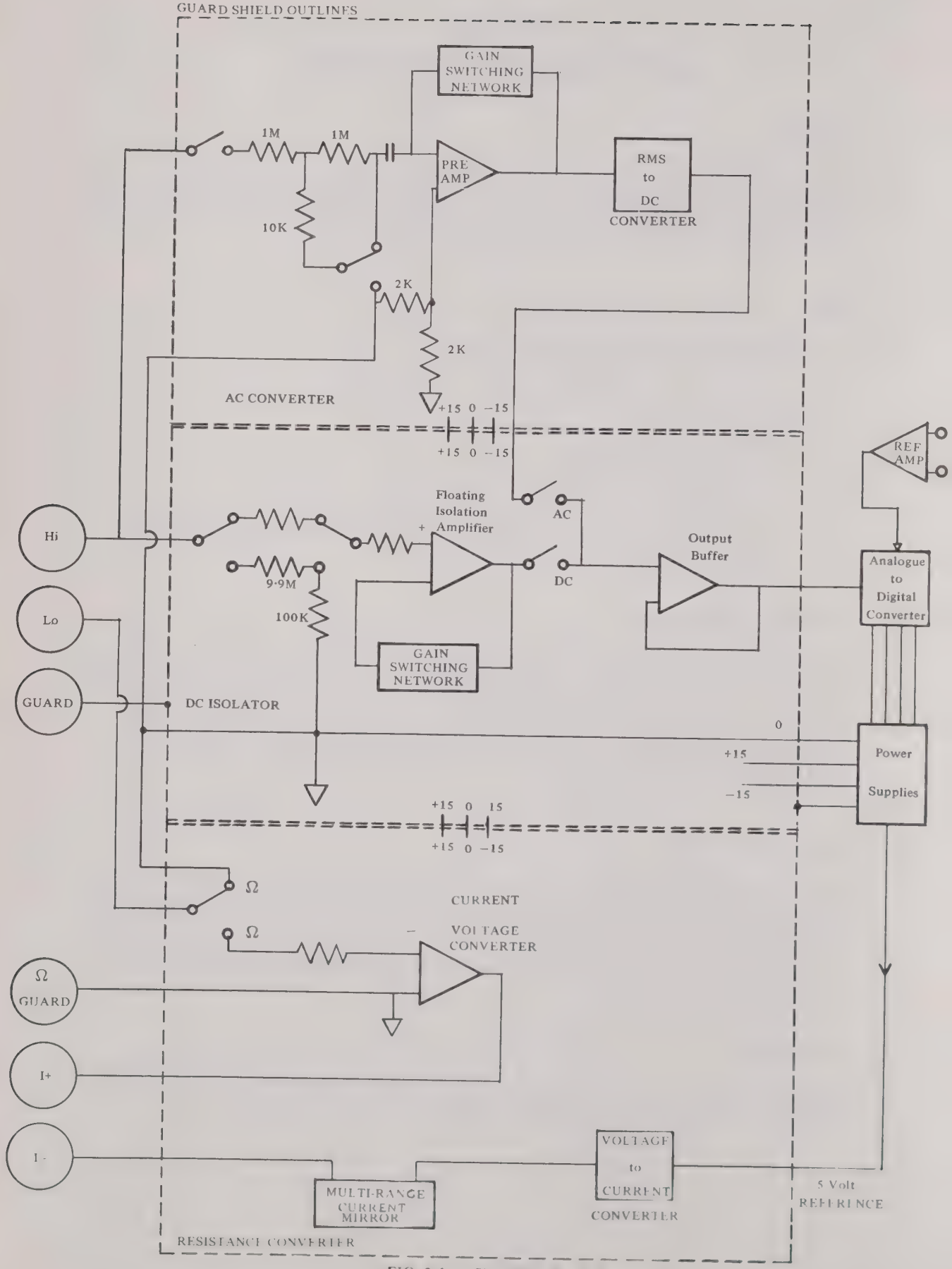


FIG. 2:1 Simplified Block Diagram

2.2.3 Ranging

Ranging is accomplished by one of three methods. Selection of a particular range by depressing the appropriate front panel push button, programming a particular range via the optional remote programming facility, or automatic ranging under control of the Analogue to Digital converter which "decides" whether the displayed result is acceptable and adjusts the range accordingly.

2.2.4 AC Converters

The True RMS sensing AC converter options are of unique design and capability. Unlike thermal converters these electronic units meet their linearity (% FS) specifications over the full range of input signals from zero to full scale. They are also very fast responding and less susceptible to temperature variations.

2.2.5 Resistance Converter

The true 4-wire resistance converter measures resistance from ·001 Ω to 19,999,000 Ω. It has features to enable full accuracy to be maintained even when measuring very low or very high resistances and can even measure resistance "in circuit". The true 4-wire technique enables up to 100 Ω to be tolerated in any lead without degrading accuracy. Thus it would be possible to **accurately** measure contact resistances on low resistors in a system with long connection leads. Ohms Guarding is provided to prevent error currents from flowing in shunt paths thus allowing high orders of accuracy when measuring high resistances. Certain shunt paths can be guarded out when making in circuit measurements.

2.2.6 Analogue to Digital Conversion

The choice of circuit used for conversion of the analogue output signal Vo, obtained from the Output Buffer, to digital form was governed, amongst other factors, by considerations of normal mode rejection. The phenomenon of normal mode noise and the necessity for its rejection is a well understood fact of life in the field of low-level DC measurement. By using Guard Shield techniques, any normal mode noise voltages can be greatly reduced, and the remaining superimposed AC waveform totally rejected by resorting to a technique similar to the commonly used dual-slope integration method of analogue-to-digital conversion.

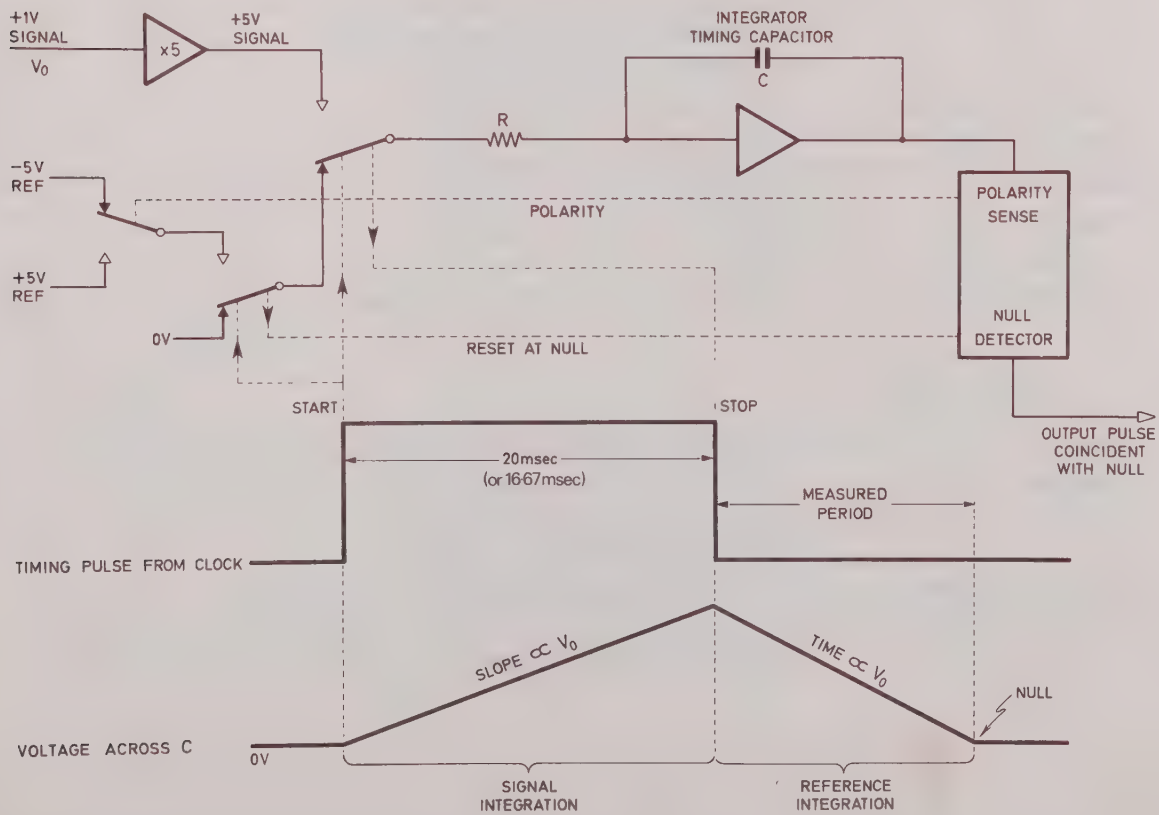


Fig. 2:2

Fig. 2:2 shows a simplified functional diagram of the converter section. The purpose of this part of the circuit is to convert the input signal Vo into a time-period directly proportional to the input voltage. The 1-volt signal is first amplified to give a 5-volt signal. This is applied via electronic switching, controlled by timing pulses, to resistor R connected to the virtual-earth input of a very high-gain integration amplifier. Capacitor C always starts the integration period from a state of zero change, and now commences to charge up at a rate proportional to the input voltage. The signal integration period lasts for exactly 20 msec, during which time capacitor C acquires a charge proportional to Vo.

At the end of 20 msec, resistor R is disconnected from the incoming signal and transferred to an accurate 5-volt reference source of opposite polarity to that of the input signal. The length of time it takes to discharge capacitor C to zero volts is directly proportional to the state of charge acquired during the signal integration period which, in turn, is proportional to the input voltage Vo. The instant that the voltage across capacitor C reaches zero is signalled by a pulse from the Null Detector, and fed as a strobe pulse to the display circuitry. The same pulse is used to disconnect the reference voltage, and reset the circuit ready for the start of the next timing pulse.

In the event of capacitor C acquiring a reverse charge during the signal integration period, the Null Detector incorporates a polarity-sensing circuit; this ensures that the reference potential is always of the correct polarity to discharge capacitor C and thus allows measurements of either polarity without reversing the input signal.

2.2.7 External Reference Buffer

The reference buffer or ratio option is a precision isolation buffer which takes a signal in the range 0.2 to 1.2 volts, amplifies it with a gain of 5 and drives the reference circuitry of the analogue to digital converter in place of the internal reference. The buffer is an active 4-wire device providing 1000 Megohms input impedance and a common mode capability (relative to signal input Lo) of 10 volts. Although the reference input can only be positive it can normally perform ratio measurements with negative reference signals simply because it is floating from the signal input terminals and can thus be connected "backwards".

2.3. SPECIFICATIONS

2.3.1 General

Power Supply	210 – 255 or 105 – 126 volts, 48 – 440 Hz. Specify line frequency and voltage when ordering. Consumption is approximately 15 VA.
Operating Temperature	0°C to 50°C
Storage Temperature	–25°C to +70°C
Dimensions	H = 90 mm (3.5"), W = 440 mm (17.25"), D = 343 mm (13.5").
Weight	5.5 kg (12lbs).
Rack Mounting	"Ears" mounted on side of instrument.
Specification Validity	For 6 months over 18 – 28°C or as described.

2.3.2 D.C. Voltage Measurement

Ranges	10.000 mV, 100.00 mV, 1.0000 V, 10.000 V, 100.00 V, 1000.0 V Automatic.
Overrange	100% i.e. 19999 full scale (FS) on all ranges except 1000.0 V.
Accuracy	After mV offset adjustment, all ranges. ±0.01% reading ±0.005% FS ±1microvolt.
Temperature Coefficient	±1/10 [of above accuracy rating] /°C ±0.2 microvolts/°C.
Stability	After six months use better than above rating per year plus microvolt offset of typically less than 2 microvolts per month.

Common Mode Rejection (1 KΩ Source Unbalance)	DC >140 dB AC >80 dB + SERIES MODE up to 174 dB.	
Series Mode Rejection	**FILTER OUT**	>20 dB @ 50 Hz increasing at 30 dB per octave + NOTCH REJECTION
	FILTER IN	>57 dB @ 50 Hz increasing at 18 dB per octave + NOTCH REJECTION
	NOTCH REJECTION	>50 dB @ Line Frequency ±0.15% 36 dB @ Line Frequency ±1%
	FILTER OUT - (OPTION F01)	NOTCH REJECTION alone.
Settling Time (to 0.01%)	**FILTER OUT**	<78 milliseconds.
	FILTER OUT (F01)	< 5 milliseconds.
	FILTER IN	<350 milliseconds.
Read Rate	Maximum independent reading rate with a nominal full range signal.	
	FILTER OUT	10/second
	FILTER OUT (F01)	20/second
	FILTER IN	2.5/second
Maximum Input Voltage (Withou damage)	Signal Hi to Signal Lo	1000V (Any Range)
	Signal Lo to Guard	250V
	Guard to Earth (Case)	500V
	Any Terminal to any - other in "ohms"	250V DC or r.m.s.

Note: The small slide switches near the terminals connect OHMS GUARD [=Lo in voltage measurement] to GUARD or I+ to Hi and I– to Lo. Therefore if a voltage is applied across these connected (via the switches) terminals, then **SEVERE DAMAGE COULD OCCUR** necessitating the replacement of the switches and the input terminal PCB.

Input Resistance (Rin)	10 mV to 10 V ranges (up to 20V) Rin >10,000 MΩ 100 V and 1,000 V ranges Rin =10 MΩ ±0.1%	
Input Current	<50 pA drifting at <2 pA/°C	
Auto Range	Ranges up at 200% of Nominal Range Ranges down at 10% of Nominal Range	
	Range Speed (Typical):–	
	FILTER OUT UP	160 milliseconds per Range
	FILTER OUT DOWN	120 milliseconds per Range
	FILTER IN UP	550 milliseconds per Range
	FILTER IN DOWN	500 milliseconds per Range

2.3.3 AC Voltage Measurement

2.3.3.1 Option 1.1

Ranges	1.0000 Volts, 10.000 Volts, 100.00 Volts, 1000.0 Volts, + Auto.
Overrange	100% i.e. 19999 FS except 1000V.
Accuracy	6 months duration 18.28°C <2 x 10^7 V/Hz.
	*40 Hz – 5 kHz ±0.1% reading ±0.02% FS
	5 kHz – 20 kHz 0.2% reading ±0.05% FS
	20 kHz – 100 kHz 0.3% reading ±0.1% FS

2.3.3.2 Option 0.1

Ranges	10.000 mV, 100.00 mV, 1.0000 Volts, 10.000 Volts, 100.00 Volts, 1000.0 Volts + Auto
Overrange	100% i.e. 19999 FS except 1000 Volts
Accuracy	6 months duration 18-28°C $< 2 \times 10^7$ V/Hz.
	100 mV – 1000 Volt ranges:–
	*40 Hz – 5kHz ±0.03% reading ±0.01% FS
	5 kHz – 20kHz ±0.06% reading ±0.02% FS
	20kHz – 100kHz ±0.1% reading ±0.05% FS
	add 1ppm per volt above 300 Volts – Bandwidth approximately 5 MHz.
	10 mV range [signal $>$ 300 μV.]
	*40 Hz – 5kHz ±0.1% reading ±0.05% FS
	5 kHz – 20kHz ±0.2% reading ±0.05% FS
	Bandwidth approximately 500 kHz.

2.3.3.3 Both AC Converters

Where * noted above read 250 Hz instead of 40 Hz if Filter is Out [360 Hz if Option F01 is fitted].

Temperature Coefficient	$<$ 1/10 [above accuracy rating] /°C
Common Mode Rejection	1 kΩ unbalance in Hi $>$ 120 dB @ DC – 60 Hz.
	1 kΩ unbalance in Lo $>$ 80 dB @ DC – 60 Hz.
Settling Time	(To 0.1% of final value attacking)
	FILTER OUT $<$ 80 msec.
	FILTER IN $<$ 350 msec.
Settling Time	(To 0.1% of range, decaying)
	FILTER OUT $<$ 150 msec.
	FILTER IN $<$ 500 msec.
Settling Time	(From severe overload).
	Up to Double the above times.
Settling Time	(From DC Bias Input).
	Time Constant 2.2 Secs.
Maximum Input Voltage	1500 V peak on any range.
	$< 2 \times 10^7$ V/Hz.
	Measures AC component with up to 1000 V DC bias on any range.
Conversion Type	True r.m.s. (AC coupled).
Input Impedance	1MΩ shunted by 75 pF (150pF with rear input).

2.3.3.4 Resistance Measurement Option 02

Ranges	10.000 Ohms, 100.00 Ohms, 1.0000 kΩ, 10.000 kΩ, 100.00 kΩ, 1000.0 kΩ, 10,000 kΩ, + Auto.
Overrange	100% on all ranges.
Accuracy	6 months duration 18-28°C.
	10 Ohms range ±0.01% reading ±0.01% FS.
	100 Ohms to 100 kΩ ±0.01% reading ±0.005% FS
	1 Megohm ±0.02% reading ±0.005% FS
	10 Megohm ±0.1% reading ±0.005% FS
Temperature Coefficient	1/10 [above accuracy rating] /°C
Type	True 4-wire with active guard (can be switched to 2-wire on front panel).
	Ratio measurement technique not dependant on internal reference voltage.

Current Through Unknown	10Ω and 100Ω ranges	10.000 milliamps
	1 kΩ	1.0000 milliamps
	10 kΩ	100.00 microamps
	100 kΩ	10.000 microamps
	1 MΩ	1.0000 microamps
	10 MΩ	100.0 nanoamps

Lead Resistance Up to 100Ω may be tolerated in any or all the leads on any range without degrading the accuracy. Resistances up to 100 kΩ may be tolerated on the higher ranges provided that the lead resistance does not drop more than 1 Volt across it due to the measurement current in the above table.

Ohms Guard

Drive Capability I+ or Lo to OHMS GUARD 250 Ohms min.

Guarding Capability Down to 20% of range or limited by drive capability [i.e. minimum resistance between OHMS GUARD and SIGNAL Lo]for less than 0.01% accuracy degredation Lower percentage of range will degrade accuracy as:–

$$\frac{\text{FULL RANGE}}{\text{GUARDED RESISTANCE}} \times 0.002\% \text{ reading.}$$

Response Times Depends on external capacitance and guarding and shielding techniques used. Generally up to 100 kΩ response is as DC . Higher resistances may take longer to settle. OHMS GUARD may be used to guard out stray capacitance.

2.3.3.5 External Reference (Ratio) Option R02

Capability DC/DC AC/DC OHMS/DC

Type 4-wire positive reference

Ranges SIGNAL : 1 Volt.
Signal input as function and range. Reference input + 0.2 Volts to +1.2 Volts.

Accuracy $\pm X\%$ reading $\pm Y.\frac{1}{REF}$ % FS

Where: X = appropriate % reading spec. for signal input range and function selected.
Y = appropriate % full scale spec. for signal input range and function selected.
e.g. For DC signal input:– $\pm 0.01\%$ reading $\pm 0.005.\frac{1}{REF}$ % FS.

Temperature Coefficient 1/10 [above accuracy rating] /°C

Input Resistance 1000 MΩ Differential. 100 MΩ Ref. Lo to Signal Lo.

Common Mode Voltage ± 10 Volts maximum

Common Mode Rejection >60 dB DC-60 Hz.

Maximum Reference Input (Without Damage) 250 Volts DC or r.m.s.

2.3.3.6 Analogue Output

Range 0 ±2 Volts, 1 Volt per nominal Full Range.

Output Resistance <10 Ohms

Output Current Up to 5 milliamps.

Protection Fuse protected against accidental overload in both Output Hi and Output Lo leads.

2.3.3.7 BCD Output Option B01 gives reading, range and function 1.2.4.8. +ve true TTL compatible code. External Hold and Read Command facilities are provided together with signal integrate and print command output flags. FAN OUT : 4 TTL LOADS, FAN IN : 2.
Option B02 is as B01 but with the added facility of turning all the outputs into a high impedance condition (i.e. "OFF") and disabling all inputs.
Both options are electrically isolated from the signal input terminals.

2.3.3.8 Programming

Option P01 gives the capability of fully programming the instrument with TTL signals via a rear panel mounted connector. All ranges and functions may be programmed and all front panel controls disabled with the exception of the two terminal slide switches. Fan in 1 TTL load maximum.

2.4 SPECIFICATION VERIFICATION

A checking routine to ensure that the instrument is working within its specified accuracy is given in Section 6, SPECIFICATION VERIFICATION. The checking procedures given are suitable for incoming inspection purposes, or for use as a periodic check of instrument calibration. Full calibration procedures are given in Section 7, MAINTENANCE, particularly useful being the OVERALL FINAL CALIBRATION procedure.

SECTION 3

CONTROLS AND OPERATION

3.1 INPUT CONNECTIONS

Six signal input terminals are located on the front panel marked respectively Hi, Lo, GUARD, I+ (Ohms current positive), I– (Ohms current negative), and Ohms Guard. They are Red, Black, White, Brown, Blue and Yellow respectively. The terminals are mounted on a standard 0.75 inch (19 mm) spacing and connection may be made using 4 mm single or double banana plugs.

In order to minimise thermal E.M.F., copper wire should be used connecting the instrument and preferably passed through the side entry holes of the Hi and Lo terminals.

Two slide switches are mounted adjacent to the terminals. The 2-wire 4-wire switch connects Hi to I+ and Lo to I– in the 2-wire position to facilitate general purpose medium accuracy resistance measurements and the GUARD – LOCAL/REMOTE switch connects the Guard terminal internally to the Lo terminal (to OHMS Guard when in OHMS) when in its LOCAL position.

Ohms GUARD is internally connected to Lo in voltage measurement and thus on no account may power be applied between the two. For the same reason on no account may power be applied across the shorting action of the slide switches when they are closed, i.e. between Hi and I+, Lo and I– and Lo and GUARD.

Note:

The following input voltages must not be exceeded under any circumstances:–

Hi to Lo	1000 Volts DC or r.m.s. or 1500 Volts peak.
Lo to GUARD	250 Volts peak.
GUARD to EARTH	500 Volts peak.
I+ or I– to Lo	250 Volts DC or r.m.s.
I+ or I– to Ω GUARD	250 Volts DC or r.m.s.
I+ to I–	250 Volts DC or r.m.s.

Full details of the recommended methods of making connection between the input terminals and the circuit under test are given in Section 3.3.1.

3.2 PUSH BUTTONS

The push buttons are in four groups labelled RANGE, MODE, FUNCTION and CONTROL.

3.2.1 Control Group

POWER

A push button switch with alternate ON/OFF action is mounted in the centre of the front panel. It isolates the mains supply live from the instrument with the exception of the mains fuse, socket and filter which remain live unless the supply lead is disconnected.

HOLD

The instrument normally free runs taking about 3 readings per second but on depressing the HOLD button the internal command mechanism is disabled. Any conversion in progress is completed and displayed: the display being held until HOLD is released or a COMMAND initiated either via the BCD connector or the MANUAL push button.

MANUAL

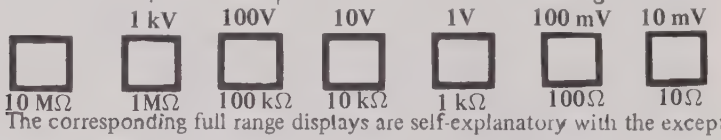
This is a momentary action button whose operation is only enabled when the HOLD button is depressed. A single reading is then indicated when the MANUAL button is pushed. Care should be taken since contact bounce can cause double commanding. If the instrument is in the Auto-range mode then upon receipt of a single manual command it will range, inhibiting the print command, until the correct range is reached. A print command is then generated and no more readings taken until MANUAL is again depressed.

PRINT INHIBIT

When this button is depressed the print command flag of the BCD output is held low to arrest any print action which is occurring. If option B02, with three state outputs, is fitted PRINT INHIBIT turns all the outputs into the "OFF" or high impedance state and disables the command control inputs.

3.2.2 Range Group

There are seven range buttons which are interlocked such that only one at a time can be depressed. The push buttons are marked from right to left:–



The corresponding full range displays are self-explanatory with the exception of 10 MΩ and 1 MΩ where the display is,in fact, 10000 kΩ and 1000.0 kΩ respectively. The 10 MΩ push button is only valid in OHMS.

OVERRANGE is signified by a 1 being illuminated at the left of the normal display. 100% overrange permits a maximum display of 19999 except on the 1 kV range where it is limited by a maximum input voltage of 1000.0 Volts.

OVERLOAD results in blanking of the digits above 100% overrange. The decimal points and function lights remain illuminated.

3.2.3 Mode Group

AUTO

When AUTO is depressed the instrument will take readings and automatically select the range which gives the most accurate display. It ranges up to a less sensitive range if a reading results in OVERLOAD and ranges down if the result is less than 10% of the nominal range. It automatically stops on the highest or lowest range applicable to the function selected. On releasing the AUTO button the instrument immediately returns to the range selected by the range buttons.

REMOTE

When the REMOTE button is depressed all the RANGE, FUNCTION and other MODE buttons are disabled.Remote programming is then enabled and a $\overline{\text{REMOTE}}$ output flag generated on the programming connector. Holding down the $\overline{\text{REMOTE}}$ line externally also performs the same function irrespective of where the button is.

FILTER

Depressing the FILTER button increases the series mode AC noise rejection when measuring DC volts or resistance and enables AC measurements to be made down to 40 Hz. It also slows down the response time and whilst the internal read rate remains the same Autoranging commands are internally delayed to allow for the increased settling time.

3.2.4 Function Group

The three functions AC– DC or OHMS are selected via the three interlocked function switches in a self explanatory manner. If all three buttons are released or if the instrument is in the REMOTE mode it assumes that DC has been selected. In instruments where the AC or OHMS options are not installed then the appropriate switch is mechanically prevented from being pushed in.

3.2.5 mV Offset

This is a screwdriver operated multi-turn preset control to enable the instrument to be adjusted for zero input signal applied to the 10 mV range. Its range is approximately ±80 microvolts and it can then be used very effectively to compensate for external offsets as well as the instrument's own very low, long term zero drift.

3.2.6 Rear Panel Controls

POWER FUSE

The supply to the mains transformer primary windings is protected by a 300 mA rating 20mm x 5mm glass cartridge fuse of the type variously known as "delay", "slow blow", "time lag" or "anti-surge". The fuse may be inspected and, if necessary, replaced by unscrewing the cap of the fuseholder located on the rear panel of the instrument.

Suitable replacement fuses are:–

Belling Lee	L2080/300
Radiospares	A/S Fuse 20mm 300mA.
A.F. Bulgin	Type F286/300 mA.

REFERENCE INT/EXT (OPTION)

This slide switch enables either internal or external reference if Option R02 (external reference or Ratio) is installed. A 5-pin socket allows application of external reference signals.

REAR INPUT (OPTION)

A 9-pin connector , connected in parallel to the input terminals, optionally allows the signal to be applied via the rear panel. THIS MEANS THAT IF HIGH VOLTAGE IS APPLIED TO ONE CONNECTOR THE OTHER COULD BE AT A DANGEROUS POTENTIAL.

ANALOGUE OUTPUT AND FUSES. (OPTION)

A 5-pin connector giving a 1V full range DC output per full range input. It is not isolated from the input terminals but fused in both High and Low lines with a fast action 15 mA fuse.

BCD OUTPUT (OPTION)

A 50-way AMPHENOL "BLUE RIBBON" connector providing TTL logic level codes for reading range and function.

PROGRAM (OPTION)

A 14-way AMPHENOL "BLUE RIBBON" connector enabling programming of all ranges and functions.

POWER SOCKET

A 3-pin CEE regulation 250V, 6A power socket accepts the mating plug which is integrally moulded with the power lead.

3.3 OPERATION

Preliminary Checks

1. Check that the instrument is correctly adjusted for the mains supply to which it is to be connected. See Section 1.2.1.

Note:

No fine tapping adjustments are required for voltages within each of the major ranges.

2. Connect the mains supply leads.
3. Switch on the supply and allow the equipment to stabilize.
4. Before commencing any further, read Section 2, Section 3.1 and 3.2 and in particular the Note in Section 1, page1.

3.3.1 Common Mode and Guard

Common Mode Voltages are equally present on both terminals of the voltage source being measured and excessive levels, either AC or DC, can affect the measurement being made. However, sensible use of the GUARD terminal can reduce errors to a negligable level.

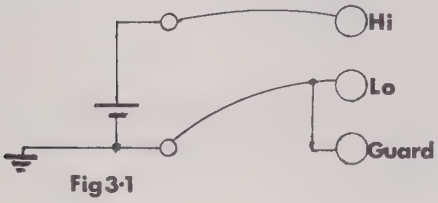


Fig 3·1

The disadvantage of the simple arrangement in Fig. 3:1 is that the connecting leads form a loop. If a stray alternating magnetic field from the mains transformer of a neighbouring instrument passes through the loop it will behave as a single turn secondary winding, and unwanted AC voltages will be induced into the measuring circuit.

The GUARD terminal should be used when the source to be measured presents an unbalanced impedance to the measuring terminals and Common Mode Voltages are present. In general, regardless how the Hi and Lo terminals are connected, the GUARD terminal should refer to the source of Common Mode Voltage as shown in Figs. 3:2, 3:3, 3:4 and 3:5.

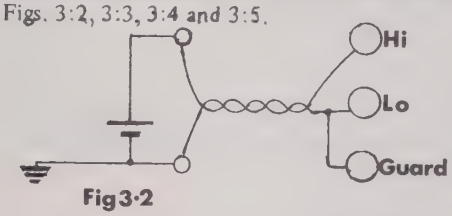


Fig 3·2

Fig. 3:2 is a better arrangement, where the twisted pair reduces the loop area and adjacent twists of the wires produce cancellation of any induced voltages.

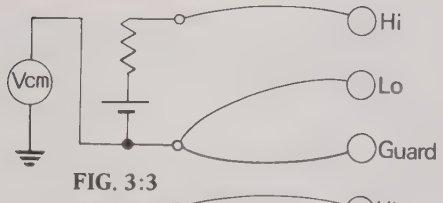


FIG. 3:3

The simple case in Fig. 3:3 allows the GUARD to be connected remotely or at the terminals since in both cases it is to the source of Command Mode Voltages.

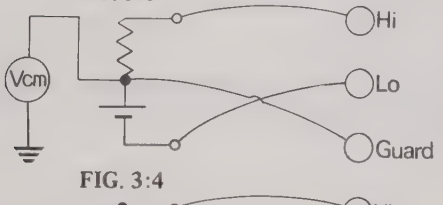


FIG. 3:4

Fig. 3:4 shows a case where the Common Mode Voltage is not present on the Lo measurement terminal and should therefore be connected remotely.

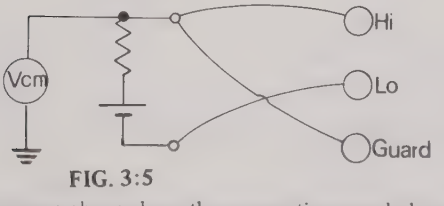


FIG. 3:5

Fig. 3:5 shows an extreme situation where all the unbalance to Common Mode Voltage is in the Lo lead and GUARD must therefore be connected to Hi.

The cases above show the connections made by use of individual wires, it is recommended, however that a screened twisted pair microphone cable be used with the GUARD terminal connected to the screen. Table 3.1 below lists the recommended types.

TABLE 3.1

Manufacture	Type	pF/metre	Outside diameter
Suhner	G03939	65	4.6 mm
Suhner	CB04730	195	5.3 mm
Transradio	MC 02-A	115	4.4 mm
Transradio	MC 02-D	130	3.5 mm
B.I.C.C.	9442Y	120	5.7 mm

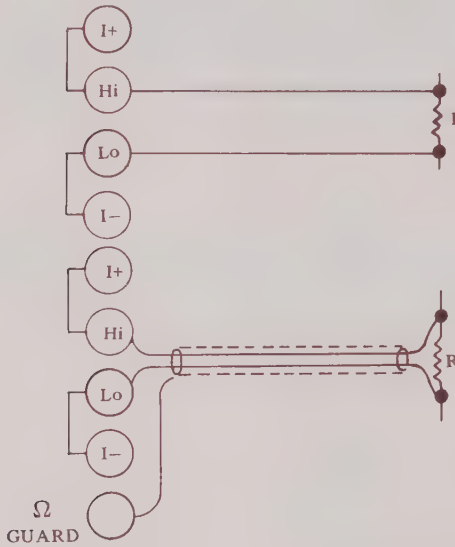
When making a particular measurement, choose the most suitable method of connection and check that it does not involve exceeding any of the input voltages listed under Section 2.4.

3.3.2 Special Notes – Thermal e.m.f.

Where very low level measurements are being made, care must be taken to minimise and balance thermal e.m.f. generated in the leads. In general, the use of steel probes, croc-clips and all metals with the exception of copper is to be avoided.

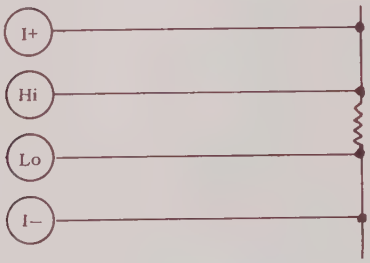
3.3.3 Resistance Measurements

Resistances can be most simply measured by switching the front panel slide switch to "2-wire" thus connecting I+ to Hi and I– to Lo. The unknown resistor is then simply connected between Hi and Lo.

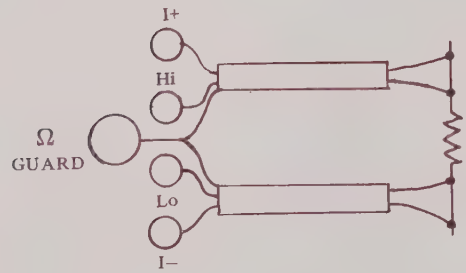


This system measures Rx but has the snag that lead resistances are in series with Rx and thus provide a measurement error. The leads are also unscreened and pick up considerable noise particularly where Rx is high.

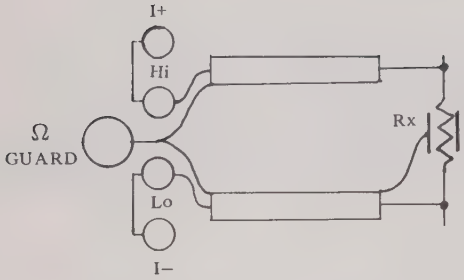
This system overcomes the noise problem described above but still may not be suitable for the accurate measurement of very low or very high resistances particularly when the leads are long. GUARD should be switched to LOCAL.



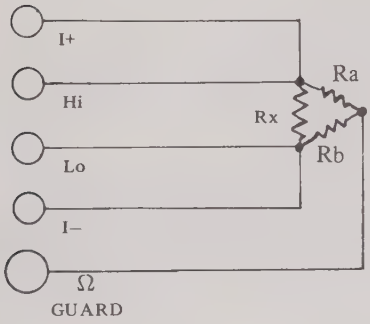
Any resistance in the leads in this system has no effect since, if in the current leads it does not effect the current through Rx and sense leads are very high impedance and not carrying current.



This method combines ideal screening with the 4-wire technique. It is also suitable for high resistances with long cables since the effects of leakage and capacitance between the wires is eliminated.



In this case a two-wire technique is used for very high resistance measurements and the OHMS GUARD connected to a guard screen wrapped around the resistor (or the case it is mounted in).



This system shows how OHMS GUARD can be used to make "In-circuit" measurements. Provided RA and RB are no less than 250Ω or 20% of RANGE then the system measures Rx to full accuracy. It may of course be combined with the screening techniques above.

Additional shunt paths may also be connected to OHMS GUARD provided the parallel combination is no less than 250Ω or 20% of range.

SECTION 4

OPTIONAL REMOTE OPERATION

4.1 OPTION (BO1): 1-2-4-8 BCD OUTPUT

4.1.1 Description

Option (BO1) enables full Binary Coded Decimal outputs describing Reading Range and Function to be obtained from a 50-way Amphenol blue ribbon connector (J5) mounted on the rear panel. The outputs are isolated from the signal input terminals and referred to earth via a 100 KΩ resistor.

Whilst it is recommended that the output digital common be referred to true earth, the input terminals may be floated as high as 500 volts relative to true earth and digital common.

The 50-way connector (J5) also provides various control lines and flags, enabling complete external control of the Analogue to Digital convertor. All levels are TTL compatible, with a fan-out of 4.

4.1.2 Connections

The table below (and on the following page) lists the various functions of the pins on connector J5. BCD output numbers are given magnitudes that assume operation on the 1 V Range. Bar notation indicates that a low level (less than 0.4 V) is 'active' or 'enables' the described state.

e.g. $\overline{mV}$ means that pin 32 is low (less than 0.4 V) when the instrument is operating in either of its two permitted millivolt conditions: 10 mV or 100 mV

J5 Pin No.	Function	Description
1	2×10^{-4}	BCD Output No.
2	4×10^{-4}	" " "
3	8×10^{-4}	" " "
4	1×10^{-4}	" " "
5	2×10^{-3}	" " "
6	4×10^{-3}	" " "
7	8×10^{-3}	" " "
8	1×10^{-3}	" " "
9	2×10^{-2}	" " "
10	4×10^{-2}	" " "
11	8×10^{-2}	" " "
12	1×10^{-2}	" " "
13	2×10^{-1}	" " "
14	4×10^{-1}	" " "
15	8×10^{-1}	" " "
16	1×10^{-1}	" " "
17	OVERLOAD	Indicates signal greater than 19999 BCD Output Number
18	1×10^{0}	
19	Not used	
20	Not used	
21	Not used	
22	Not used	
23	Not used	
24	Not used	
25	$\overline{\text{EXTERNAL REF}}$	0 Indicates EXTERNAL
26	PLUS POLARITY	1 Indicates positive reading
27	MINUS POLARITY	1 Indicates negative reading
28	$\overline{\text{OHMS}}$	0 Indicates Resistance Measurement
29	$\overline{\text{DC}}$	0 Indicates DC Measurement
30	$\overline{\text{AC}}$	0 Indicates AC Measurement

J5 Pin No.	Functions	Description
31	$\overline{\text{FILTER}}$	0 Indicates FILTER: 1 = NORMAL
32	$\overline{\text{mV}}$	0 Indicates mV: 1 indicates Volts
33	$\overline{\text{AUTORANGE}}$	0 Indicates AUTO, 1 Indicates MANUAL
34	$\overline{\text{DECIMAL POINT 1}}$	0 for BCD MULTIPLIER x 1
35	$\overline{\text{DECIMAL POINT 2}}$	0 for BCD MULTIPLIER x 10
36	$\overline{\text{DECIMAL POINT 3}}$	0 for BCD MULTIPLIER x 100
37	$\overline{\text{DECIMAL POINT 4}}$	0 for BCD MULTIPLIER x 1000
38	$\overline{\text{FP CONTROL}}$	INPUT control line
39	Digital COMMON	0 state reference
40	$\overline{\text{HOLD}}$	Input control line
41	$\overline{\text{COMMAND}}$	Input control line
42	$\overline{\text{PRINT INHIBIT}}$	Input control line
43	SIG. INTEGRATE	Output control flag
44	$\overline{\text{DELAY}}$	Input control line
45	$\overline{\text{PRINT COMMAND}}$	Output control flag
46	Not used	
47	Not used	
48	Not used	
49	Not used	
50	Not used	

4.1.3 Examples of BCD Coding

Suppose the following pins of J5 are in a 1 state (greater than 2.4 V):-

3 – 5 – 6 – 9 – 12 – 15 – 16

this gives a reading of:-

Pins

3	8×10^{-4}	= .0008
5 & 6	$2 \times 10^{-3} + 4 \times 10^{-3}$	= .006
9 & 12	$2 \times 10^{-2} + 1 \times 10^{-2}$	= .03
15 & 16	$8 \times 10^{-1} + 1 \times 10^{-1}$	= .9
	TOTAL	= .9368

Now suppose that pins 32 and 35 are both in a low or 0 state (less than 0.4 V):

Pin 32 low, indicates that the instrument is measuring mV.
Pin 35 low, indicates BCD x 10 (This can be interpreted as decimal point after the 2nd most significant digit . . . pin 16 being 1st significant digit.)

The reading is therefore:-

.9368 x 10 millivolts
=9.368 millivolts

Alternatively, mV may be interpreted as 'divided by 1000' giving:-

$$\frac{.9368 \times 10}{1000}$$

= .009368 volts

Pins 29, 30 and 31 are merely flags indicating a particular measurement mode, and do not affect interpretation of the BCD number. Pin 17, OVERLOAD, indicates when the input signal is too high for a particular range. BCD numbers may be present even when pin 17 is in a 1 state but **they must not be taken as valid** though they will be accurate for numbers only slightly in excess of 19999.

4.1.4 Control Lines

Pins 40 to 45 are control lines, enabling the user to control the instrument remotely when it is used in conjunction with other equipment as part of a test system. The control input lines float to a 1 or high state if open circuit, and can be held to a 0 or low state by connecting them to pin 39, digital COMMON.

4.1.4.1 Print Command: Pin 45, $\overline{\text{PRINT COMMAND}}$ falls from a 1 to 0 state at the end of each measurement cycle, when the new reading has been transferred to the storage registers and is available at the pins of J5 in the form of steady BCD output information.

The falling voltage step available at pin 45 can thus command an external reading device to take note of the BCD output or, alternatively, the 1 state can be used to inhibit scanning of the BCD information. Since the reading is stored, it is available at any time except when new information is being transferred. Pin 45 is only in the 1 state for the duration of the transfer period, lasting about 5 microseconds.

A logic low on pin 42 $\overline{\text{PRINT INHIBIT}}$ prevents the $\overline{\text{PRINT COMMAND}}$ edge from occurring on pin 45, thus making it easy to stop external printers etc. Pin 45 is forced to a low state in this condition.

4.1.4.2 Signal Integrate: Pin 43 exhibits a high state flag while the analogue to digital convertor is acquiring its information. It is made available because its falling edge represents the earliest time at which new signal information may be applied to the input terminals without disturbing the reading in hand. It can thus be used to operate a signal scanner, for example, at the highest possible speed for fully accurate information. The falling edge can also be used to command the instrument, via its delayed command facility, at the same time. See Section 4.1.4.5.

4.1.4.3 Hold Reading: Pin 40, $\overline{\text{HOLD}}$, may be externally held in a low state if it is desired to stop the instrument from reaching its normal free-run mode. When pin 40 is taken low the instrument will complete any reading in progress, followed by storing and displaying it until pin 40 is taken high or released, or until an external read command is applied.

4.1.4.4 Read Command: A falling edge on pin 41, $\overline{\text{COMMAND}}$, instructs the instrument to take one reading immediately if, and only if, pin 40 $\overline{\text{HOLD}}$ is already held low. The instrument inhibits commands that are applied before conversion in progress is complete. Fig. 4.1 shows the relationship of $\overline{\text{COMMAND}}$ and $\overline{\text{PRINT COMMAND}}$ to the integration cycle.

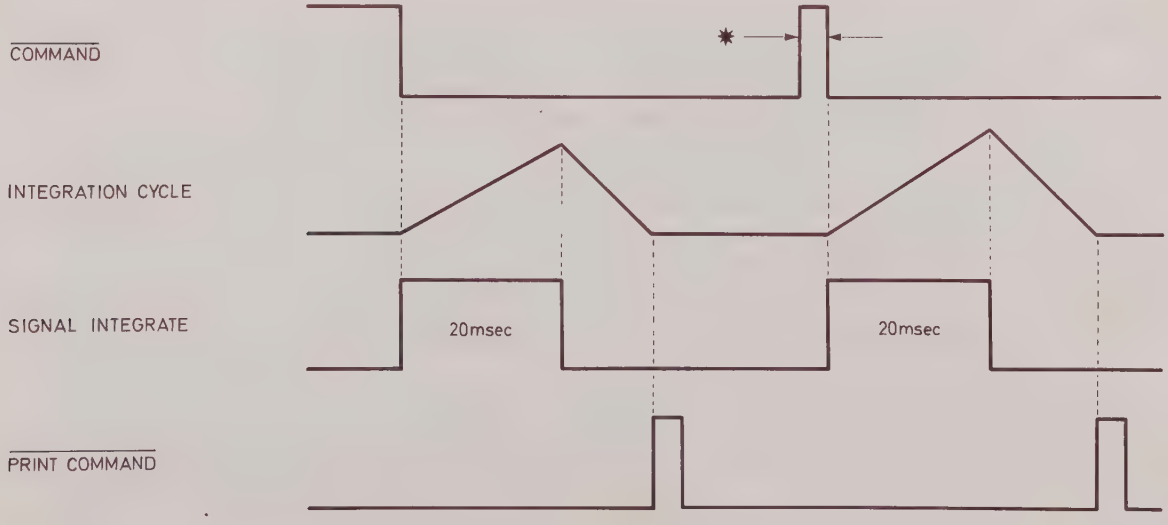


Fig. 4-1

4.1.4.5 Delayed Command: If pin 44, $\overline{\text{DELAY}}$ is held at logic 0 while an external command is applied, then the command will be automatically delayed by a period of time equal to the settling time of the integration filter. This delay is automatically adjusted depending on whether NORMAL or FILTER is selected by the front panel push button.

Provided pin 44 is held low, this means that the instrument can be commanded at the same instant that new signal information is applied to the front panel terminals. A particularly useful example of this is where the Model 1045 is used in conjunction with a signal scanner, the same command being used for stepping or switching the scanner, as for commanding a reading to be taken, see Fig. 4.2.

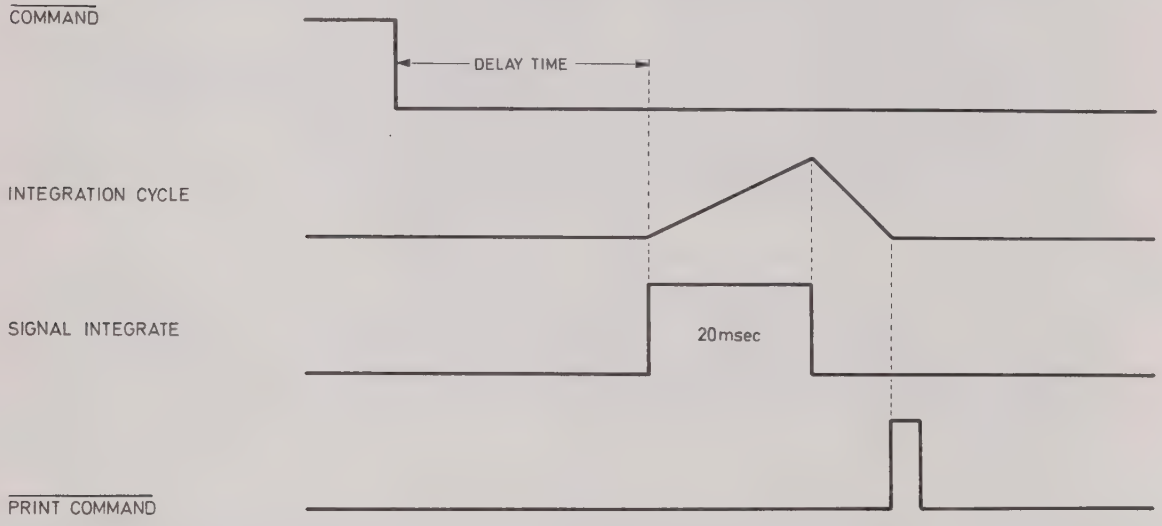


Fig.4-2

For maximum read rate in a closed-loop system, the command could be the falling edge of pin 43, SIGNAL INTEGRATE, see Fig. 4.3.

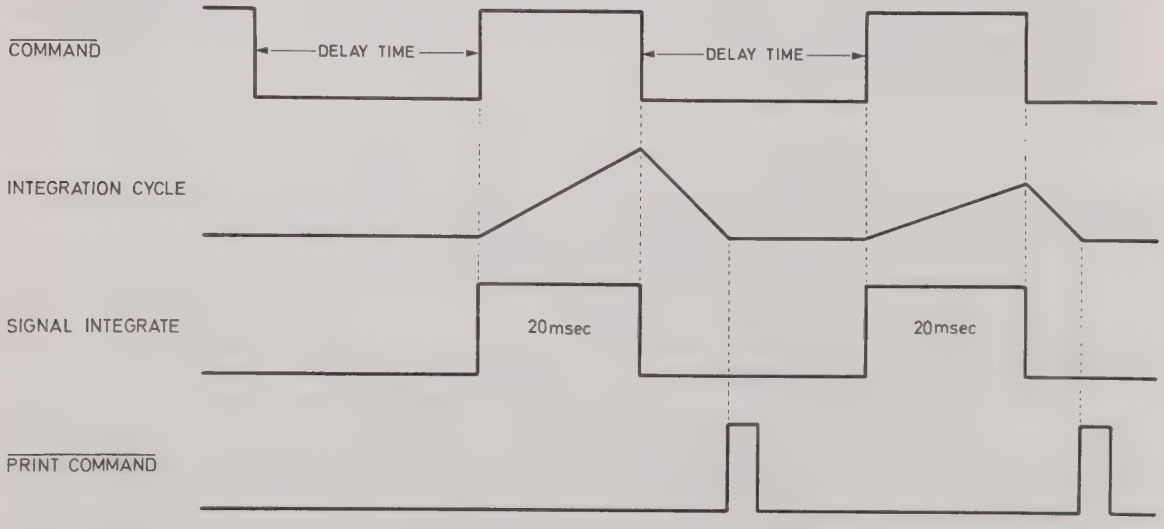


Fig.4-3

4.1.4.6 **FP Control:** If pin 38 is held low the front panel control push buttons are inhibited, i.e. PRINT INHIBIT, MANUAL and HOLD.

4.1.4.7 **"O" State Reference:** All digital outputs and command lines are referred to digital COMMON on pin 39. Maximum fan-in is 2 TTL loads, minimum fan-out capability is 4 TTL loads.

4.2 OPTION (BO2): THREE-STATE LOGIC OUTPUT

Option BO2 is a 3-state (or "Tri-state" *) version of Option BO1. The basic difference is that upon application of a logic low to pin 42 $\overline{\text{PRINT INHIBIT}}$ or upon depressing the Print Inhibit button if enabled (see 4.1.4.6.), all active BCD and control lines are inhibited. The output lines are forced to a "third state" which is a very high impedance OFF state.

The instrument can therefore be permanently connected to logic highways or bus-bars in a system and then, by application of a single logic 0 tp pin 42, electrically disconnected at will. An important example of this would be where the BCD outputs of several instruments are connected in parallel to a printer: a simple single pole switch could be used to select the output from a particular instrument for printing.

* Trade mark: National Semiconductor Inc.

4.3 PO1: REMOTE PROGRAMMING

4.3.1 Description

Option (PO1) enables all ranges and functions on the Model 1041 to be remotely programmed via the 14-way Amphenol, rear panel mounted connector. All the programme lines are electrically isolated from the signal input terminals via opto-electronic isolators. Programme common (digital common) may be floated to a different potential from earth but is internally referenced to earth via a 100K resistor. It is therefore recommended that programme common be referred to earth in the measurement system; the signal input terminals are then able to float ± 500 volts peak relative to earth and digital common.

4.3.2 Method of Operation

The optional Programme Board is directly mounted on the rear panel connector and connected to the digital circuitry at the front of the DC isolator mother board (ASSY No. 400035) via a 16-way ribbon cable to connector J4. The programme signals enter 2-way multiplexers M1 and M8 which select signals from the programme lines or from the front panel switches depending on whether $\overline{\text{REMOTE}}$ is selected or not. $\overline{\text{REMOTE}}$ is selected by depressing the front panel push button and an output code $\overline{\text{REMOTE}}$ indicating this state is available on the programme connector. Alternatively if programme override is required then with the addition of a link (normally supplied fitted) then the output $\overline{\text{REMOTE}}$ code is wire-ored with the internal $\overline{\text{REMOTE - COMMAND}}$ line such that the instrument may be held in its remote condition by holding the $\overline{\text{REMOTE}}$ pin on the rear panel connector in a low state. An external system may thus be in complete control of the instrument whatever the condition of any or all of its push button controls

The function control signals are decoded and passed through opto-isolators M12, M13 and M14 as previously described (section 5.2.6 and 5.2.7).

The range programme lines normally float to a "1" state and since this includes the AUTO line which overrides then this line must be held low to effect programme control of range. Range is then selected by forcing the states of the range counter M2 as described in sections 5.2.6 and 5.2.7, and thus to perform the range switching via optical isolators M9, M10 and M11.

4.3.3 Pin Connections

The following tables give the pin connections and codes for programming via the 14-way Amphenol connectors.

4.3.3.1 Range Connections

The table below shows the required states to programme the seven ranges. Note that the 10 Megohm range is, of course, only valid if ohms is also selected otherwise it behaves as a 1KV range except for the decimal point position.

PIN NO.	8	9	10	11	12
RANGE					
10mV/Ω	1	0	0	0	0
100mV/Ω	0	1	0	0	0
1V/KΩ	1	1	0	0	0
10V/KΩ	0	0	1	0	0
100V/KΩ	1	0	1	0	0
1000V/KΩ	0	1	1	0	0
10,000KΩ	1	1	1	0	0
AUTO	X	X	X	1	0

Note that AUTO overrides any range selection made and thus $\overline{\text{AUTO}}$ must be programmed to permit any particular range to be sellected and, of course, REMOTE must be commanded either at the front panel or via the programme connector as described.

4.3.3.2 Function Connections

In this table the function codes are given. They are definitive except for FILTER which may be selected or not whatever other function has been. This is denoted by X.

PIN NO.	1	3	5	7	12
FUNCTION					
DC VOLTS	X	1	1	X	0
AC VOLTS	X	0	1	X	0
RESISTANCE	X	1	0	X	0
FILTER	1	X	X	X	0
NORMAL ($\overline{\text{FILTER}}$)	0	X	X	X	0
RATIO (Ext. Reference)	X	X	X	0	X

4.3.4 Characteristics of Use

As described in section 3.2 the programme lines float to a "1" state and normally if programme is enabled by REMOTE, but no codes programmed, then the instrument will relax to the safe condition of AUTO, DC VOLTS.

The tables in sections 3.3.3.1 and 3.3.3.2 must be adhered to if sensible results are to be obtained but damage is unlikely to occur if forbidden codes are programmed.

Programme logic levels are TTL compatible with a fan-in no greater than TTL load. A "0" state should be no greater than .4 volts relative to Programme Common (Pin 2) and a "1" state no less than 2.4 volts.

Programme lines are not protected against over voltage transients and therefore great care should be taken to ensure that no spikes, even of very short duration, exceed 5 volts relative to pin 2, programme common.

4.3.5 Other Options

Other programme and BCD output options are available to special order. In general interfacing the 1041 with a system designed for another voltmeter is not difficult. Do not hesitate to consult the factory for advice.

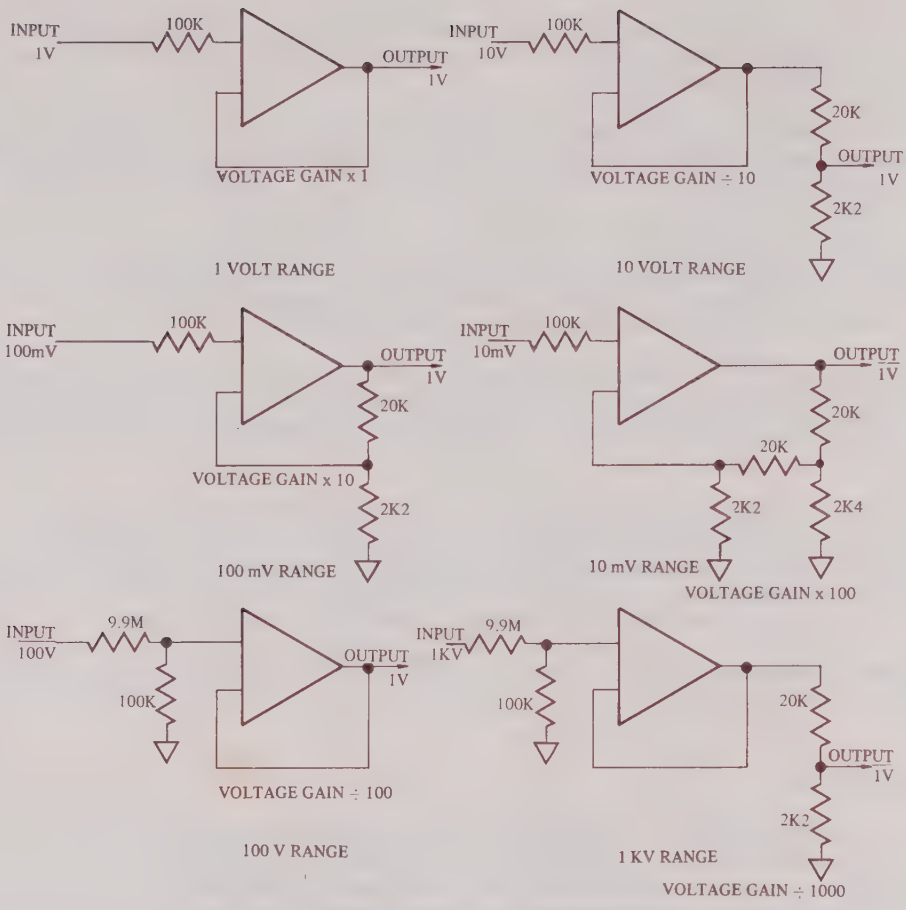


FIG. 5:3 SEPARATE RANGE SWITCHING

On the 100V and 1KV ranges a ÷100 10MΩ input attenuator is switched in. This is a matched set of resistors for low temperature coefficient.

On selecting 10mV, Q43 and Q44 are turned on: all other F.E.T's are turned off. The output of M21 the preamplifier 1C is then connected to its inverting input via R21, R22, R24, R25 an attenuator chain of ÷100 which gives the amplifier an overall gain of X100. Q44 connects the preamplifier directly to the output buffer M22

On selecting 100mV Q42 and Q44 are turned on: all other F.E.T.'s are turned off. M21 output is connected to its inverting input via R21, R22, a ÷10 attenuator. The overall amp gain is X10. Q44 again connects the preamplifier directly to M22.

With 1V selected Q41 and Q44 are turned on. The preamplifier output is now connected directly to its inverting input giving a gain of unity.
For 10V range Q41 is kept on, retaining a preamplifier gain of unity but the output of M21 is attenuated by 10 (R33 – R34) before being passed to the output buffer via Q45 instead of Q44.

The 100V range selects the 1V range and inserts a ÷100 attenuator (R57, R60) between the Hi and the preamplifier input.

The 1KV range selects the 10V range and also inserts the same ÷100 attenuator at the front end.

5.2.2 Preamplifier

The preamplifier is designed to present an input impedance of greater than 10000MΩ for signals up to ± 20V.

Bootstrapping (tracking of both ground lines and supply voltage with input signal) is essential for correct operation of input bias compensation, input offset voltage compensation, temperature compensation, F.E.T. switching and common mode rejection.

M23 is a high impedance buffer which looks at the inverting input of M21. The offset of M23 is adjusted so that its input is within 100 μV of the input of M21, (The signal). M23 thus functions as a low impedance rail following the signal precisely.

By means of zener diode level shifting M24 and M25 produce outputs tracking +10V and –10V respectively from the bootstrap rail. These rails power the pre-amp M21 and the bootstrap-amp M23 as well as driving the switching to the F.E.T. gates. For example with +15V on the high terminal the +ve supply of M21 is +25V and the –ve supply +5V. This produces excellent common mode rejection.

It should be obvious that this immediately requires a higher supply voltage than the ± 15V stabilized rails provide. With the maximum +20V of signal this means a supply of +30V stabilized is needed for the +BS rail and to provide this nearly 40V is required. A capacitive inverter driven from M26 provides ± 38V from the ± 15V rails.

Zener diodes ZD3, ZD4 provide levels approximately fifteen volts above and below bootstrap. Emitter followers Q52 and Q53 provide a low output impedance for these rails which power M24 and M25. This is necessary to prevent the voltage rating of M24 and M25 from being exceeded. With signals of less than ±200 mV the output followers Q52 and Q53 are slightly less than the ± 15V stabilized rails. Diodes CR12 and CR14 conduct instead and so for low level signals the BS rails are powered from the ± 15V rails and not from the ± 38V rails.

This simplifies the problem of supply line rejection in the preamplifier as the 15V rails have very little ripple on them.

5.2.3 Drift compensation

M21 is a super-beta device (not a Darlington) selected by Datron after a long high temperature on power burn in. The device exhibits a nominal voltage drift of ± 5μV/°C and a typical bias current of 1 nA. Q51 is kept in close thermal contact with M21 by cyanocryolate adhesive and the whole input stage is under a draught excluding plastic moulding. Q51 has a base emitter voltage which changes at the same rate with temperature as the bias current of M21. Consequently a current derived from Q51 base emitter and fed into M21 input will compensate for the bias current. Tracking to ± 2pa/°C is achieved in this way.

To compensate for voltage drift, the drift is first measured in an oven and a correcting offset then injected which will reverse the drift.

The final drift is <0.3μV/°C from 0 to 50°C. For more complete description see Maintenance (Section 7).

5.2.4 Filtering

In $\overline{\text{FILTER}}$ mode, by use of a 5-pole active filter of switchable size, the isolator board has a response to 0.01% in 80 mS with an attenuation of 20 dB. In FILTER, it has a response to 0.01% in 350 mS with an attenuation of 57 dB. In the $\overline{\text{FILTER}}$ mode, Q46, Q47 and Q48 are switched off and the filter comprises C25, C24, C26, C14 and C19. In the FILTER mode, Q46, Q47 and Q48 conduct thus connecting into circuit C17, C18 and C16. To reduce the effects of dielectric absorption all capacitors on the front end are polypropylene, the remaining effects are compensated by Q58, C37, C36, R81, R82 and R61.

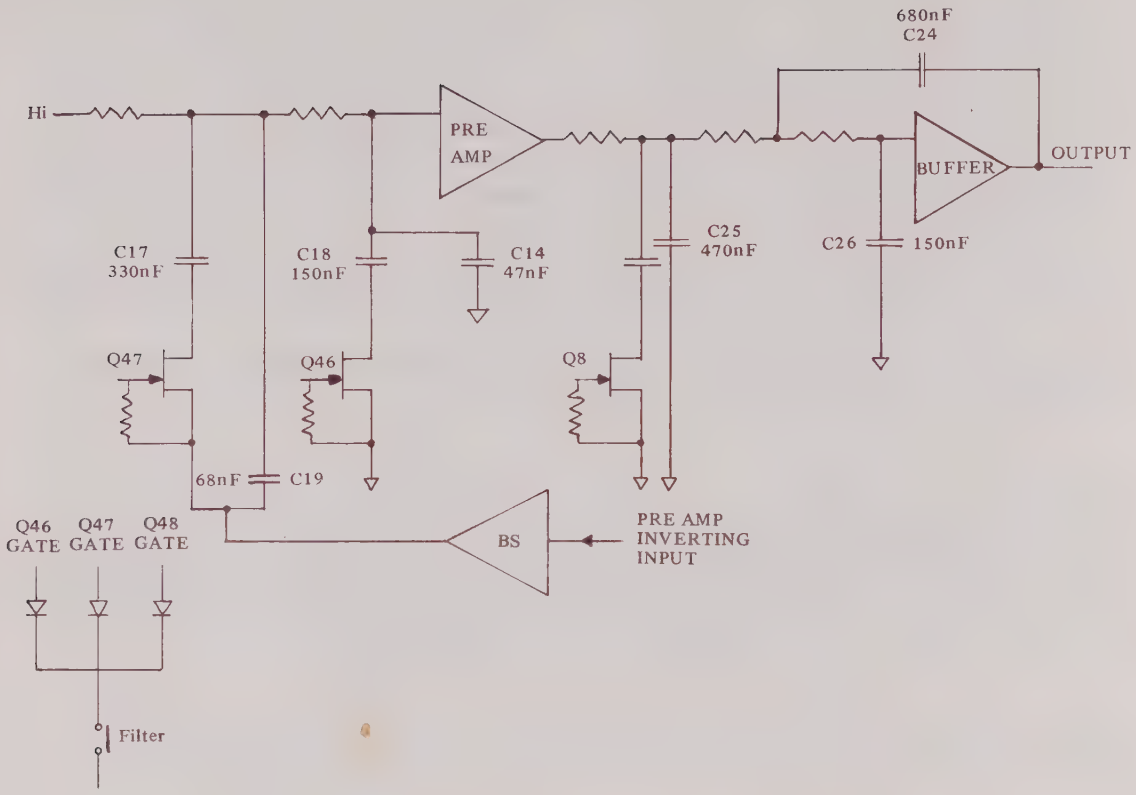


Fig. 5:4 FILTER NETWORK

5.2.5 Isolator range coding/decoding (Drawing 430010, sheet 1).

M9 – M14 are optical isolators separating the auto range digital circuits from the isolator circuit. The outputs of M9, M10, M11 form a range code in BCD format. M12 calls up the resistance converter card, M13 the AC card and M14 filter.

Q18 – Q23,Q27 and the resistor diode matrix R182, R189, CR101 – CR140 decode the BCD from M9 – M11 and recode it for the AC card and the resistance card. Q28 – Q30, Q33 – Q37 code the drive to the FET's on the DC isolator.

Examining the BCD code more closely:

Range	M9	M10	M11	Q18	Q19	Q20	Q21	Q22	Q23
10 mV	0	0	1	1	1	0	0	0	1
100 mV	0	1	0	1	0	1	0	1	0
1V	0	1	0	1	0	0	0	1	1
10V	1	0	0	0	1	1	1	0	0
100V	1	0	1	0	1	0	1	0	1
1 kV	1	1	0	0	0	1	1	1	0

In the case of Q18 – Q23 a '1' represents≈+15V and a '0'≈–15V.

These codes remain the same whether DC, AC or Ω is selected. The outputs of the diode matrix following Q18, Q23 are modified by the selections of DC, AC or Ω.

5.2.5.1 DC coding

When 10 mV is selected the collectors of Q18, Q19, Q23 are at +15V: Consequently the junction of CR127 – CR131/R188 is +ve and this turns FET Q43 on, which gives a preamp gain of X100.

Q21 is –ve, which turns Q28 on and in turn Q35. This turns Q37 off. The collector of Q37 is now +ve, turning FET Q44 on, connecting the preamp directly to the output buffer.

When 100 mV is selected, the collectors of Q18, Q20, Q22 are at +15V consequently the junction of CR 117 – CR 121/R 186 is +ve. This turns Q29 off and in turn Q33 off. The collector of Q33 goes +ve and this turns FET Q42 on giving a preamp gain of X10. Q21 is still –ve, thus Q28 is on, Q35 off Q37 off and FET Q44 on, again connecting the preamp directly to the output buffer.

When 1V is selected neither of the two previous codes are present. Q33 and Q34 are both on, this turns Q36 off and F.E.T. Q41 on, giving a preamp gain of X1. Q21 is still –ve, so Q44 is still on.

When 10V is selected Q20 and Q21 are high. The junction of CR132 – CR134, CR140, R189 is +ve, turning Q28 off, turning F.E.T. Q45 on. Q36 is still off. This calls up a preamp of unity again but divided the output by ten before passing it to the output buffer.

On both 100V and 1KV, RL1 is pulled in, connecting the 100:1 input attenuator in circuit. Q27 is at +15 when **either** Q19 is low and Q23 low **or** Q22 low and Q20 low. Thus on 100V and 1KV the junction of CR114 – CR116, CR147, R197 is high, turning Q26 on, pulling in RL1.

If 10MΩ is incorrectly selected in DC the 1KV range will be called up by the range logic on the analogue side of the opto-isolators.

5.2.5.2 AC Coding

When AC is selected M13 turns Q31/Q32 on. These pull RL1 in, turn Q35, Q37 on and F.E.T.'s Q44/Q45 off. The preamp on the DC isolator is thus totally disconnected from the output buffer M22. This now receives its input via R38 from the AC converter. Note that these actions are effective on AC regardless of the range selected.

The AC converter receives 4 lines of coded range information via pins 1,3,5,7.

Range	Pin 1	Pin 3	Pin 5	Pin 7
10mV	0	1	1	1
100mV	0	1	0	1
1V	0	0	0	1
10V	1	0	0	1
100V	0	0	0	0
1KV	1	0	0	0

If 10MΩ is incorrectly selected in AC the 1KV range will be called up, by the range logic on the analogue side of the opto-isolators.

5.2.5.3 Resistance Converter Coding

The collectors of Q18 – Q23 are fed directly to the resistance converter without being modified in the diode matrix. However, before the opto-isolators in the range logic an extra range, 10MΩ, is added. The BCD code for this is

M9	M10	M11	Q18	Q19	Q20	Q21	Q22	Q23	
1	1	1	0	0	0	1	1	1	10MΩ

The DC isolator is used on the ohms ranges, with a gain of X1 on all except the 1OR range, when it is X10. On selecting ohms, M12 turns Q24 on and Q25 off. This modifies the diode matrix outputs to the DC isolator. Holding Q26 and RL1 off on the '100V' (100K) and 1KV (1MΩ) positions. Q28, Q35 and therefore F.E.T. Q44 are also turned on, coupling butter to preamp directly.

5.2.5.4 Filter

M14 passes the FILTER command to Q38, turning it on. F.E.T.'s Q46, Q47 and Q48 are all turned on via D1 D3, inserting larger capacitors in the 5 pole active filter of the DC isolator. A line is also taken from Q38 to the AC converter. Filter can be called up, and is effective on DC, AC and OHMS (where it is useful for resistances in the the 10MΩ region or where long unscreened leads are used.)

5.2.6 Auto Range and Range Selection (Drawing No. 4300010, Sheet 3)

Range selection can be made by front panel push button, by remote programming via the rear panel, or automatically by auto range. Function selection can be by either front panel or remote programming.

The basis of range selection is M2, a presettable up – down counter. If AUTO is not selected, the counter is prohibited from clocking up or down and the 3 output lines are similar to the three presettable input lines. These input lines come from M1 a 4 input – 2 way multiplexer. Selections of which 3 inputs are connected to the outputs is controlled by front panel or programme REMOTE function selection. The three outputs of the up-downcounter drive opto-isolators M9 – M11 feeding a BCD range code to the DC isolator. (See 5.2.4). M6, a BCD – decimal decoder, together with M5 and Q8 – Q12 provide remote range indication for the BCD output option and range decimal point drives for the analogue to digital converter display.

When autorange is selected (AUTO) two modes are possible. If there is an overload on the range in use (i.e. ⩾20,000 digits) an UP command will come from the digital board via J3 – 13 **and** the counter will clock up one range. After a fixed period (≈100mS in $\overline{\text{FILTER}}$ and ≈500mS in FILTER) the counter will either remain in a fixed state if the reading is on scale or if still overloaded will clock UP again. This will continue until an on scale reading is achieved, or the highest range reached. Gating on M7 prevents clocking beyond the top range. Alternatively, if the reading is too small for reasonable accuracy on the range in use (i.e. < 1000 digits) a DOWN command will come from the digital board via J3 – J14 and the counter will clock down one range. Again, after a fixed period, the counter will either remain in a fixed state if the reading is between 1000 and 20,000 digits or if still underscale, will clock DOWN again. This will continue until a reading of >1000 digits is achieved or the bottom range reached. Gating on M4 prevents clocking beyond the bottom range.

An identical quad 2 way multiplexer M8 is used for function selections. Front panel or remote programming again selects which information to transfer.

M3, Q7, Q13, Q14, Q17 decode the multiplexer (M8) outputs into AC DC OHMS and FILTER which connect to the analogue-to-digital converter via J3 and to the DC isolator via opto-isolators M12 – M14 (only $\overline{\Omega}$ and $\overline{\text{AC}}$ are transmitted DC is $\overline{\Omega}$ and $\overline{\text{AC}}$).

There are two methods of remote selection. A remote programme link is fitted at the factory and EITHER front panel OR programming can call up REMOTE. If this link is removed, then only the front panel button can call up REMOTE and the programme line pin 12 becomes an OUTPUT FLAG INDICATING $\overline{\text{REMOTE}}$

5.2.7 Models 01 and 11 AC Converter

The Model 01 AC converter in an electronic True RMS AC to DC converter operating over a bandwidth of 30 Hz to 1 MHz and incorporating 6 ranges from 10mV full range to 1000 volts.

The circuitry is on one printed circuit assembly which plugs into the underside of the DC isolator mother board assembly. There are two main circuit sections, the preamplifier (Drawing No. 430016, sheet 1) which buffers and ranges the signal in order to present ·9 volts full range to the AC to DC converter section (Drawing No. 430016, sheet 2).

5.2.7.1 Preamplifier

The simplified diagram, Fig. 5:5 shows the essential features of the preamplifier and scaling circuit. For the purposes of explanation the same symbols are used (black triangular contact normally "made", white contact normally "open") regardless of whether the switching is accomplished electronically (F.E.T.) or by means of relay contacts. In Fig. 15 all switching is shown in the 1V range position.

The various switching combination for the different ranges are as follows:–

VOLTS RANGE	OVERALL VOLTS GAIN	RELAY K2	F.E.T. Q2	F.E.T. Q4	F.E.T. Q3	F.E.T. Q5
10mV	90	6 – 5	OFF	OFF	ON	OFF
100mV	9	6 – 5	OFF	OFF	ON	ON
1V	·9	6 – 5	OFF	ON	OFF	ON
10V	·09	6 – 5	ON	ON	OFF	ON
100 V	·009	6 – 7	OFF	ON	OFF	ON
1000V	·0009	6 – 7	ON	ON	OFF	ON

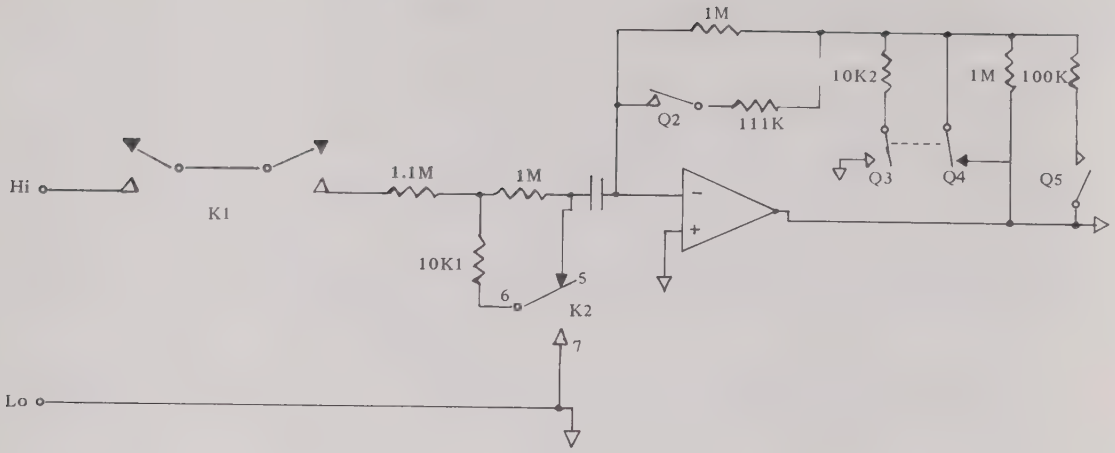
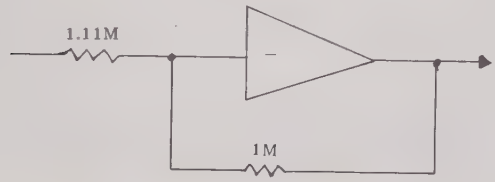


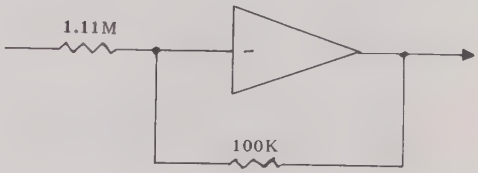
Fig. 5:5

Although the reader could, no doubt, puzzle out the different circuit configuration on each range; it will be quicker to simplify the circuit still further and to show separate drawings for each RANGE selling as shown in Fig. 5:6.

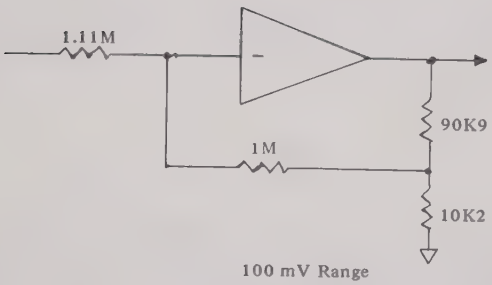
Note that in the mode 11 AC converter the 10mV and 100MV ranges are omitted, but all other circuit description descriptions are similar to the model 01.



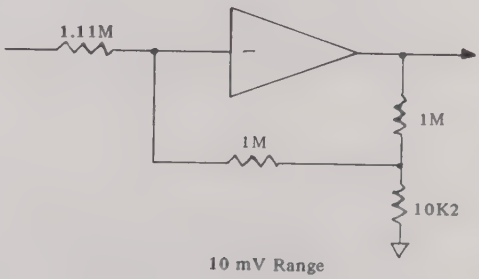
1Volt Range



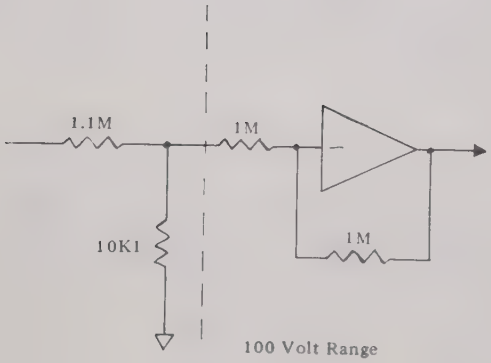
10 Volt Range



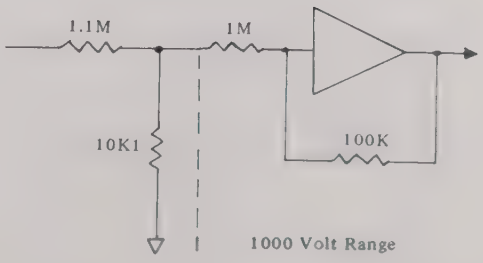
100 mV Range



10 mV Range



100 Volt Range



1000 Volt Range

Fig. 5:6

Having grasped the basic essentials reference should be made to Circuit Diagram No. 430016, Sheet 1.

Relay K1 is energized when AC is selected and directly connects resistor chain R3 – R6 to the Hi input terminal. The four resistors total 1·11 MΩ and are capable of dissipating 2Watts. Capacitors C2, C3, C4 and R7 provide frequency compensation to increase the accuracy at high frequencies. For the purposes of this description no further reference to frequency compensation will be made although, of course, every gain defining resistor is frequency compensated.

The signal current passing through R3 – R6 either flows into the virtual earth (TP1) of the preamplifier via R10 and C8 or, if K2 is energised 99% of the current is shunted to common providing the ÷ 100 condition required on the 100 and 1000 volt ranges.

The preamplifier itself is of the inverting type, is of high bandwidth and has remarkably low offset drift characteristics. Q6, Q7 and Q10 form a very high bandwidth unity gain buffer. Q6 is a dual F.E.T. operating in a unique differential mode such that each half tracks thermally. M1 is a fast operational amplifier. F.S.V. resistors R51 and R52 is selected to offset M1 such that its offset drift is very low, R41 and R42 such that the offset drift of Q6 is very low and R34 and R35 to provide zero output offset of the whole preamplifier. This is finely adjusted by R36.

The feedback network has been described previously (see Fig. 5:5 and 5:6). Note that the gain defining resistors are associated with trim adjust potentiometers and that where this is the case the compensating capacitor network is also adjustable. Two "twisted-wire" capacitors are also incorporated for very fine frequency flatness adjustments.

The preamplifier is AC coupled at its input with a 1000 volt capacitor allowing AC measurements in the presence of very high DC bias potentials. Although the AC gain is high on the millivolt ranges C22 and C23 limit the DC gain to unity.

5.2.7.2 RMS Converter (Circuit Diagram No. 430016, Sheet 2)

The RMS Converter takes the scaled AC signal from the preamplifier and converts it to an equivalent DC signal suitable for Analogue-to-Digital conversion. The conversion technique is electronic true RMS sensing as shown in the simplified block diagram Fig. 5:7.

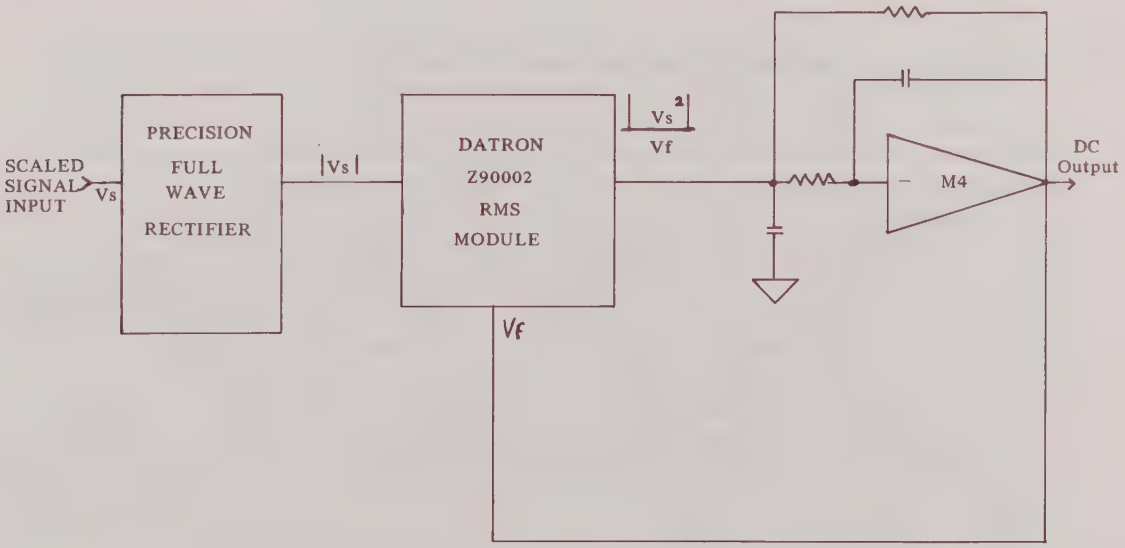


Fig. 5:7 TRUE RMS CONVERTER

With reference to Fig. 5:7 the sections are explained except for the circuitry around M4 which forms a 2-pole active filter with approximately 60dB rejection at 40 Hz (referred to input).

Mathematically the description is as follows:–

$$\text{Output voltage, Vo} = \frac{\overline{|Vs|^2}}{Vf}$$

where bar notation indicates overrange.

|Vs| is the rectified form of the input signal Vs.

Since the loop is closed:

$$Vo = Vf$$

therefore $$Vo^2 = \overline{Vs^2} \quad (Vs^2 = |Vs|^2)$$

$$Vo = \sqrt{\overline{Vs^2}}$$

Thus Vo is the true RMS value of Vs.

With reference to drawing No. 430016, sheet 2; M2 and M3 form the full-wave rectifier which is of the summing type, that is, M2 is a precision half-wave rectifier inverter the output of which is summed with the non-inverted signal, with a weighting of 2:1, at the input of M3. This forces a full-wave rectified current to flow in RMS module M6. Although the simplified block diagram of Fig. 5:7 implied that the RMS module operated with voltages it in fact operates on currents both in and out. Trim resistor R61 balances the rectifier such that a non-symmetrical waveform provides the same output whether inverted or not.

The output current from the RMS module passes into filter-buffer M4 and is converted to the output voltage. Q15 and Q16 switch in additional capacitors for operating in the FILTER mode down to 40 Hz or lower. M5 is a voltage to current converter which provides a feedback current to the RMS module which is proportional to the output voltage. R98, R109, R115 are zero adjusts for M3, M4, M5 respectively, R67 is an overall gain adjust and R70 is a high crest factor gain adjust. All these components are coarsely adjusted with FSV resistors. Q23 is turned on in AC and off in the other functions and it switches the output of the AC converter into the output buffer M22 of the DC Isolator.

5.2.8 Resistance Converter – OPTION 02 (Drawing No. 430008, Sheet 1)

This is a true 4 wire measurement and incorporates an active guard for in-circuit measurement. In many cases, 2 wire measurement is adequate and more convenient: a front panel switch is incorporated to provide for this.

The instrument functions by measuring the voltage across an unknown resistance with a known, constant, current flowing in it.

As can be seen in Section 3.3.3, 4 wire measurement can eliminate the effects of lead resistance. However, for short leads of 24/0.2mm wire, the few tens of milliohms error when measuring greater than 100 ohms soon become negligible; from this point on, 2 wire measurement becomes more attractive. Referring to drawing No. 430008, the converter is in two parts: a constant current source covering 6 decades from 10mA – 100mA and a low drift voltage follower. It should be noted that when the resistance converter is fitted the DC isolator Lo is no longer directly connected to front panel Lo, but goes via RL1 on the resistance converter. On DC, isolator Lo connects to front panel Lo. On Ohms, the front panel Lo is connected to the –ve input of M3 the +ve input of which is referred to DC isolator Lo. (This remains reference common). M3 together with output follower Q9, will thus apply a voltage at I+ such that the voltage at front panel Lo is reference 0 + offset M3 (which is zeroed to $<10\mu V$).

Consider 2 wire measurement for ease of explanation: I+ linked to Hi, I– linked to Lo, the unknown resistance between Hi and Lo. A constant current flows from Hi to Lo through the unknown resistance. The Lo terminal is maintained at $0 \pm <10\mu V$. The Hi terminal (DVM isolator input) is, I constant x R unknown, above Lo. As long as the error on Lo is small referred to reference 0, the DVM will read the correct resistance. The voltage offset error is kept small (< 1 digit) by compensating M3 in the same manner used for M21 on the isolator. (See Section 6, Maintenance).

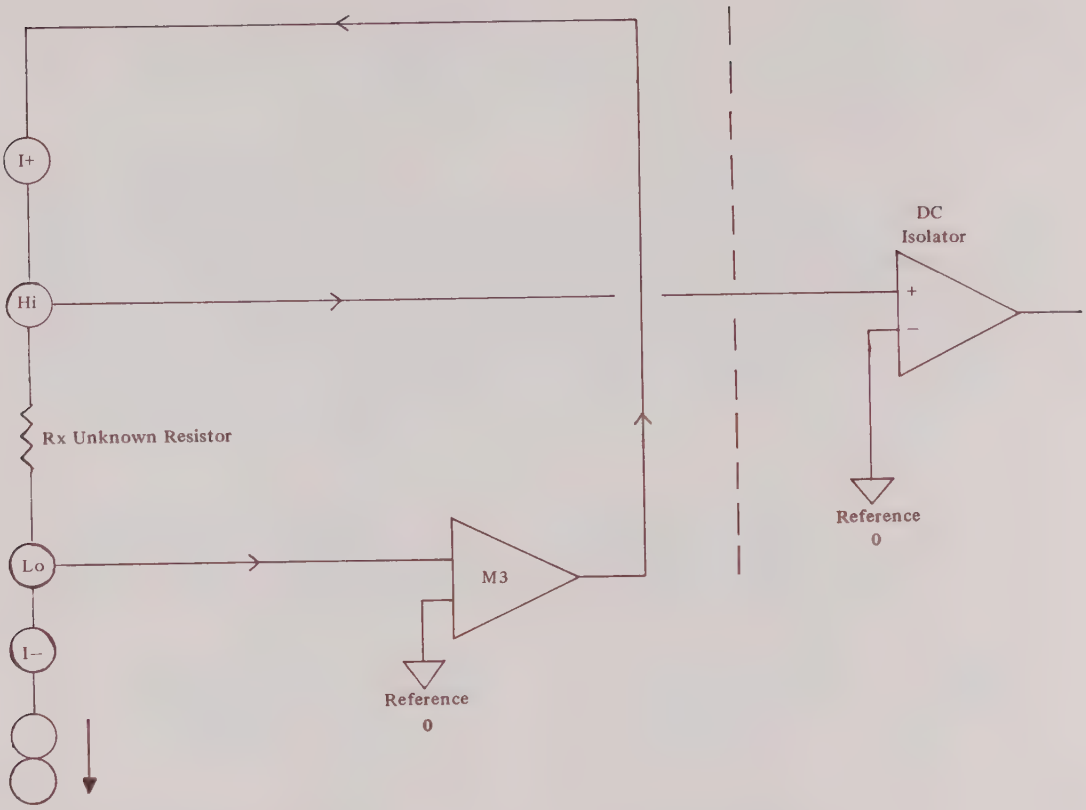


Fig. 5:8 SIMPLIFIED Ω SCHEMATIC

Seven decades of ohms ranges are provided by 6 ranges of current and 2 ranges of isolator voltage gain. The diode switch matrix on the isolator board provide 7 lines if information in BCD code. A small matrix on the Ω card provides gate drive for 6 current selector F.E.T.'s (Q2 – Q5, Q7, Q8) and for F.E.T. Q6, used for leakage reduction. M1 converts the –5V reference voltage from the digital assembly into a current of 500μA flowing in R5. R5, M2 and the switched resistors chain R6 – R54 form a current mirror: the current flowing in the chain on the right of M3 is equal to the current flowing in R5 on the left of M3 multiplied by the ratio of the right hand resistor to R5. Put even more simply, the voltage across R5 must equal the voltage across the right hand chain + offset voltage of M2. Thus a fixed voltage difference appears across the resistance chain; by varying the value of resistor, the current is varied selecting tappings on the chain.

The various currents produced are:-

		F.E.T.'s ON
10R	10mA	Q2
100R	10mA	Q2
1K	1mA	Q3
10K	100μA	Q4
100K	10μA	Q5
1M	1μA	Q6 Q7
10M	100nA	Q6 Q8

4 basic currents are provided and a 1000:1 attenuator used with two of these currents provides two more ranges.

If difficulty is experienced in understanding how the 2M/2K functions as a current divider, remember that the point the 2M is connected to is I– and this will be at most only a hundred ohms from Lo. Lo is maintained within a few μV of ref. 0 and the 2K is taken to the ref. 0. Thus the 2M is in effect shunting the 2K and the same voltage therefore exists across the 2M as across the 2K. Q6 is switched in when Q7 and Q8 are on, to sink gate leakage currents from Q2, Q5 to ground.

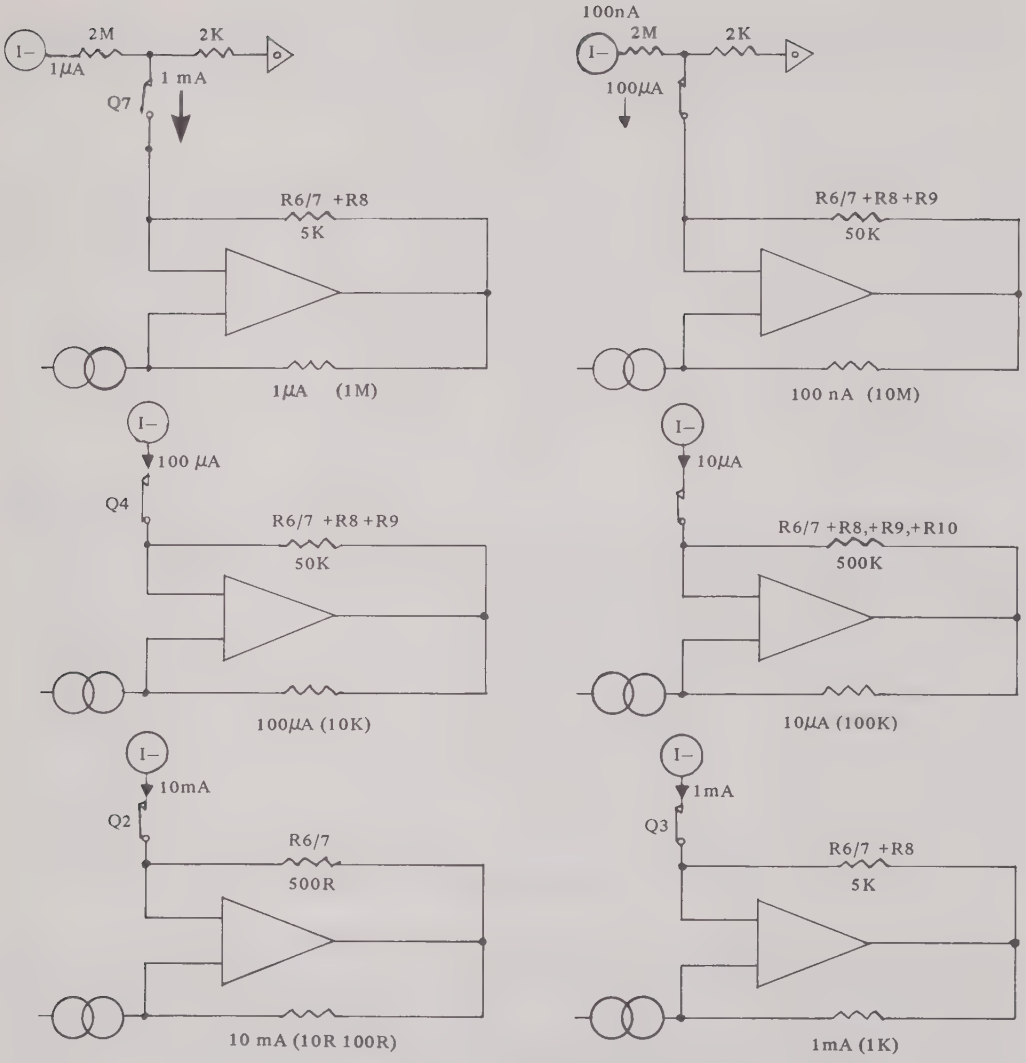


Fig. 5:9 SIMPLIFIED Ω CURRENT SWITCHING

Protection from overload in the current leads is achieved by positive temperature coefficient thermistors R47 (in the I+ lead) and R48 (in the I– lead). Diodes CR31 – CR34 and zeners CR36, CR37 prevent excessive voltages from reaching the current generator or the voltage follower output. Protection is such that 240 Vr.m.s. may be applied between I+ and I– or I+, I– to ohms guard or Lo to ohms guard. Following the application of such an accidental overload the PTC resistors R47, R48 have to cool down and this may take several minutes.

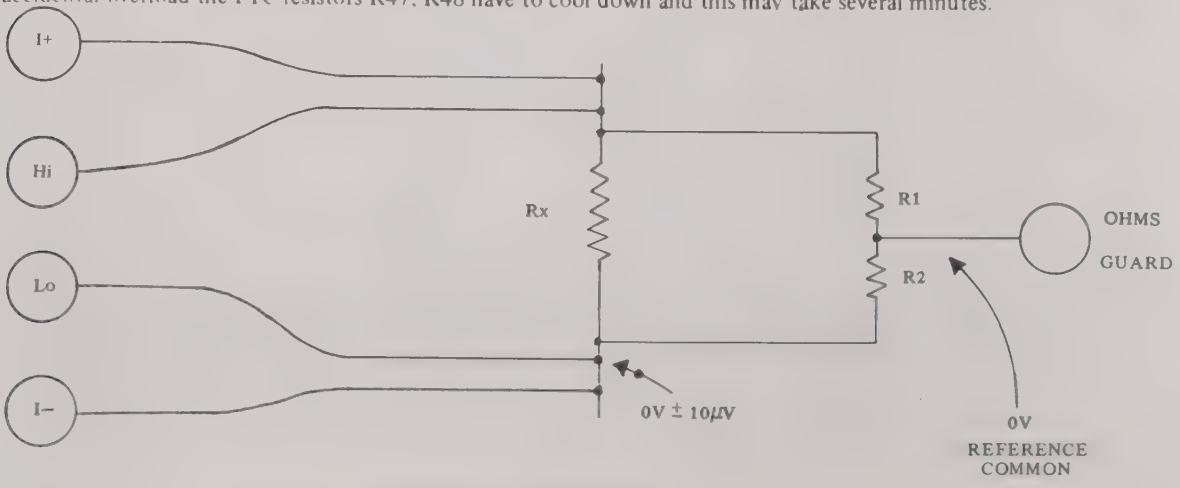


Fig. 5:10 Ω GUARD

SECTION 5

TECHNICAL DESCRIPTION

5.1 GENERAL

The internal circuits of the 1041 are divided between two printed circuit boards, in the basic machine. The first printed board (Schematic No. 430010) is the DC isolator mother board and includes the preamplifier, scaling circuits, bootstrapped supplies, and range logic. The second board (Schematic No. 430004) is concerned with Analogue to Digital conversion and produces the BCD output together with drive for the Sperry displays. The regulated power supply components are also mounted on this board. When AC and Ω are specified these are incorporated on two separate boards plugging into the main isolator mother board.

For the purpose of explanation boards will be described separately and each board further sub-divided according to the various functions involved.

5.2 DC ISOLATOR MOTHER BOARD (Assembly Drawing No. 400035)

This is split in three distinct sections: isolator, range encoding/decoding, and range logic.

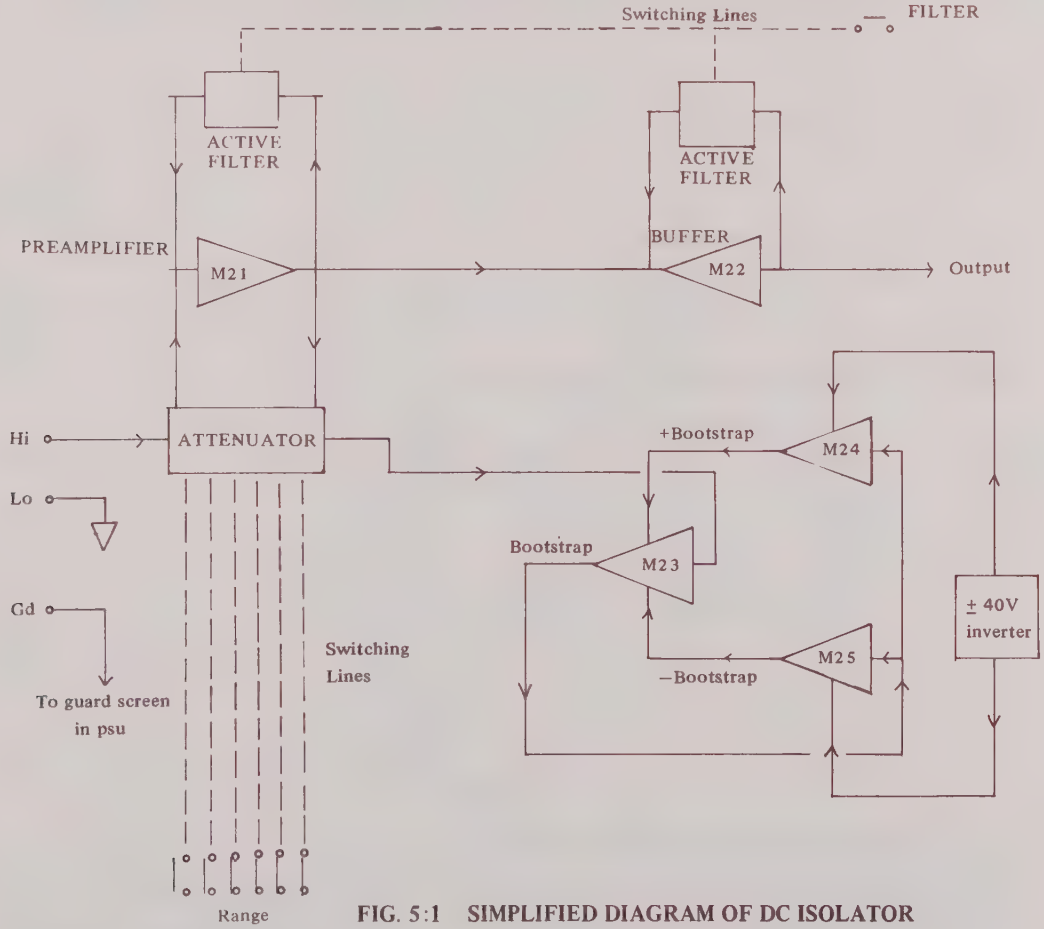


FIG. 5:1 SIMPLIFIED DIAGRAM OF DC ISOLATOR

5.2.1 Preamplifier Scaling

The simplified diagram, Fig. 5:2 shows the essential features of the isolator scaling circuit. For the purpose of explanation the same symbols are used (Black triangular contact normally 'made', white triangular contact normally 'open') regardless of whether the switching is accomplished electronically (F.E.T.) or by means of relay contacts. In Fig. 5:2 all switching is shown in the 1V RANGE position.

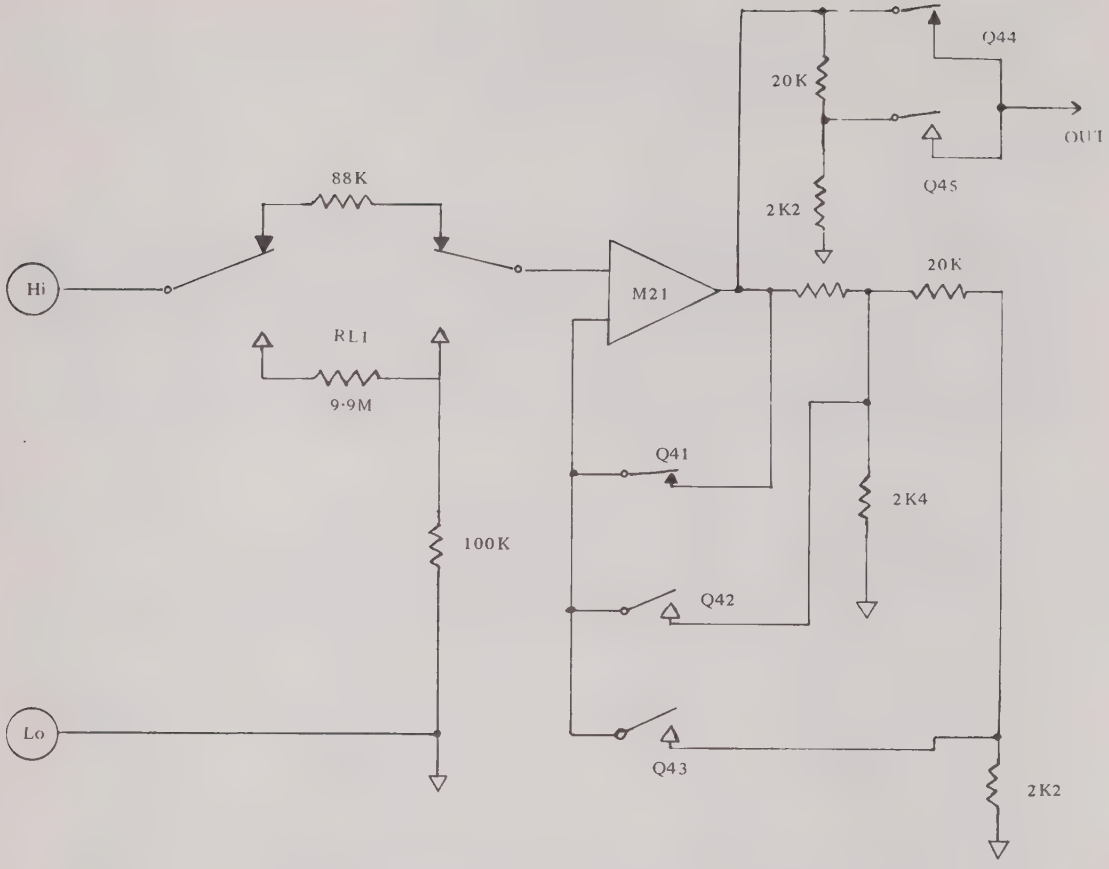


FIG. 5:2 SIMPLIFIED DIAGRAM OF ISOLATOR SWITCHING

The various switching combinations for the different ranges are as follows:–

RANGE	GAIN	Q41	Q42	Q43	Q44	Q45	RL1
10mV	X100	OFF	OFF	ON	ON	OFF	OFF
100mV	X10	OFF	ON	OFF	ON	OFF	OFF
1V	X1	ON	OFF	OFF	ON	OFF	OFF
10V	÷10	ON	OFF	OFF	OFF	ON	OFF
100V	÷100	ON	OFF	OFF	ON	OFF	ON
1000V	÷1000	ON	OFF	OFF	OFF	ON	ON

The different circuit configurations are shown in Fig. 5:3.

Having grasped the basic essentials, reference should be made to circuit diagram No. 430010, Sheet 2 for a more detailed explanation.

Resistor chain R1 – R4, 100KΩ total, is in series with the Hi input on all ranges from 10mV – 10V. The amplifier end of R4 is clamped by zener diodes ZD5, ZD6 and Q49, Q50 to the bootstrap rail which is in turn clamped to Lo (0.) by zener diodes, ZD7, ZD8. This means that the amplifier input can never exceed approximately ± 35V: the sum of the zener diode voltage drops. The 100K chain limits the current in overload. The power dissipation of the chain is such that 1000V can be applied continuously.

The use of ohms guard permits in circuit measurement of resistors, provided shunt paths are greater than 200R and a suitable tapping point is available. Consider Fig. 5:10 Ω Guard is reference 0, Lo is, as previously explained actively maintained within few μV of ref. 0. Thus there is no voltage across R2 and consequently no current in it. R2 can cause no measurement error. Thus all the constant current because it cannot flow in R2, must flow in the unknown resistance. Voltage follower M3 will simply pass more current into R1 from the I+ terminal until the selected current for the particular range flows through Rx.

5.3 ANALOGUE TO DIGITAL CONVERTER – Assembly Drawing No. 409120A

5.3.1 Analogue Section – Circuit Diagram No. 430004, Sheet 2.

Refer to Section 2.2.6 and Fig. 2:2 for the principles of integration, the two-way switches shown are, in fact, flip-flop circuits and diode logic used to switch field effect transistors (F.E.T.'s). A more realistic representation is given below in Fig. 5:11 which is shown in the RESET state, waiting for the SIG. pulse.

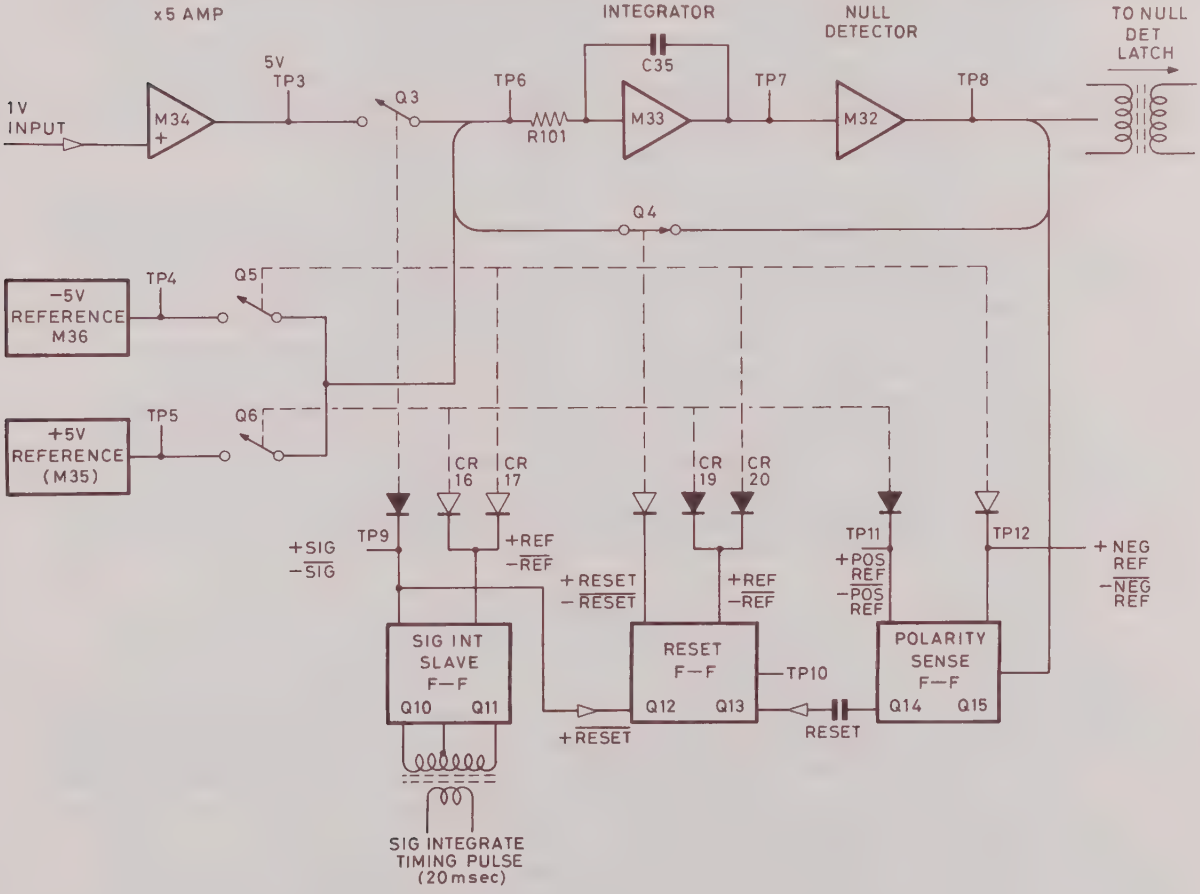


Fig. 5:11 INTEGRATOR SWITCHING

As explained in Section 2.2.6., the input signal is applied to an integrator for a set period of 20 msec, and the charge acquired by the integration capacitor during that time is proportional to the amplitude of the applied voltage. The capacitor is then discharged to zero volts by connecting the Integrator to a precise reference voltage; the length of time the reference voltage has to be applied in order to reach zero volts is measured by digital circuitry, and is proportional to the amplitude of the input signal.

The sequence of operations is best explained with the aid of a timing diagram.

Reference to the simplified switching diagram, Fig. 5:11 shows that the 1-volt FR input signal is amplified to 5-volts FR by M34 and appears in this form at TP3. A signal-integrate period is initiated by the positive-going edge of a timing pulse from the digital part of the circuit being applied to the Sig. Int. Slave F-F comprising Q10 and Q11 so that TP9 is driven positive into the SIG. state.

Apart from its primary function of closing signal-switching FET Q3, the positive SIG. voltage at TP9 changes over the Reset F-F into the $\overline{\text{RESET}}$ state and also inhibits the application of either positive or negative REF voltages by the action of logic diodes CR16/CR17 whose cathodes are taken negative.

When switching FET Q3 is turned on at the start of a signal integrate period, the signal (of some value less than 10 volts) appears at TP6 and is applied to the virtual-earth inverting input of M33 via a series resistor R101. The slope (rate of charging) applied to capacitor C35 is determined by the value of R101 (fixed) or by the voltage of the input signal. The polarity of the charging voltage at the output of M33 (TP7) is greatly amplified by the Null Detector, M32. The Null Detector circuit incorporates clamping diodes CR9/CR10 so that although a large output voltage swing occurs when TP7 departs from zero volts by only a small amount, the voltage appearing at TP8 is clamped between fixed limits.

In order to overcome the problem of uncertainty near zero a small proportion of the reference voltage selected by the reference polarity detector Q14, Q15 is fed forward to bias the null detector. This means that even with zero input signal there is a small reference ramp lasting for a period of time determined by the amount of feedforward (set by R106). This is about 7 μS and has the advantage of ensuring that a null detector pulse cannot occur at the same time as the maximum digital noise occurs, i.e. at the end of $\overline{\text{SIG}}$. Thus for zero input the display will read several digits and this is compensated for by holding the main digital counter in reset for a few clock counts during the reference period.

Null Detector output voltage at TP8 sets the polarity of the Polarity Sense F-F, attempting to apply a 5-volt reference potential by closure of Q5 or Q6 whose switching action is inhibited by the $\overline{\text{REF}}$ state of switching diodes CR16/CR17. At the end of the 20 msec. timing pulse the Sig. Int. Slave F-F changes over. TP9 goes negative to the $\overline{\text{SIG}}$ state, opening Q3 and, at the same time, switching diodes CR16/CR17 allow either Q5 or Q6 (as determined by the state of the Polarity Sense F-F) to close. Thus a reference signal of opposite polarity to the measured signal is applied to the Integrator to discharge the capacitor. The reference-integration period required for discharging the capacitor to zero volts will always be less than 40 msec. (except with an overload signal), and the instant of zero-crossing is sensed by the Null Detector. An output pulse of about 1 msec. duration appears at TP8, and the pulse leading edge is fed as a SIG. STROBE OUTPUT, via pulse transformer TR3, to the Null Detect Latch in the digital part of the circuit. The pulse at TP8 changes over the Polarity Sense F-F and also drives the Reset F-F into its RESET state. Switching diodes CR19/CR20 inhibit further reference voltage being applied by opening Q5 (Q6), and the switching FET Q4 is turned on closing the feedback loop so that C35 assumes a state of zero charge. The circuit is thus reset ready for the next timing pulse.

A further look at the Timing Diagram Fig. 5:12 shows first a positive-going input signal, followed by a negative-going signal of smaller amplitude. Note the difference in the REF. INT. period.

Power Supply Unit The mains transformer and power supply components are mounted near the rear of the Analogue-Digital Display board. Transformer TR1 is of toroidal construction with a split primary comprising two 115-volt windings. These are intended for either series or parallel connection, depending on the supply voltage. An earth screen is interposed between the primary and secondary windings to minimize electrostatic coupling; this is grounded to supply-line earth. Completely separate from the earth screen, and isolated from all windings, a further electrostatic screen is fitted to act as a Guard Shield.

Three secondary windings are provided, each with its separate full-wave bridge rectifier and solid-state regulator. Outputs from regulators M38 and M39 provide a –15 V – COMMON – + 15 V DC supply, while an 8-volt r.m.s. winding is used with rectifier W1 and regulator M37 to give a separate +5 V line. The regulators used are all capable of delivering a 1-ampere output, with foldback current limiting and thermal shut-down protection built in. No damage results to them even under short-circuit conditions.

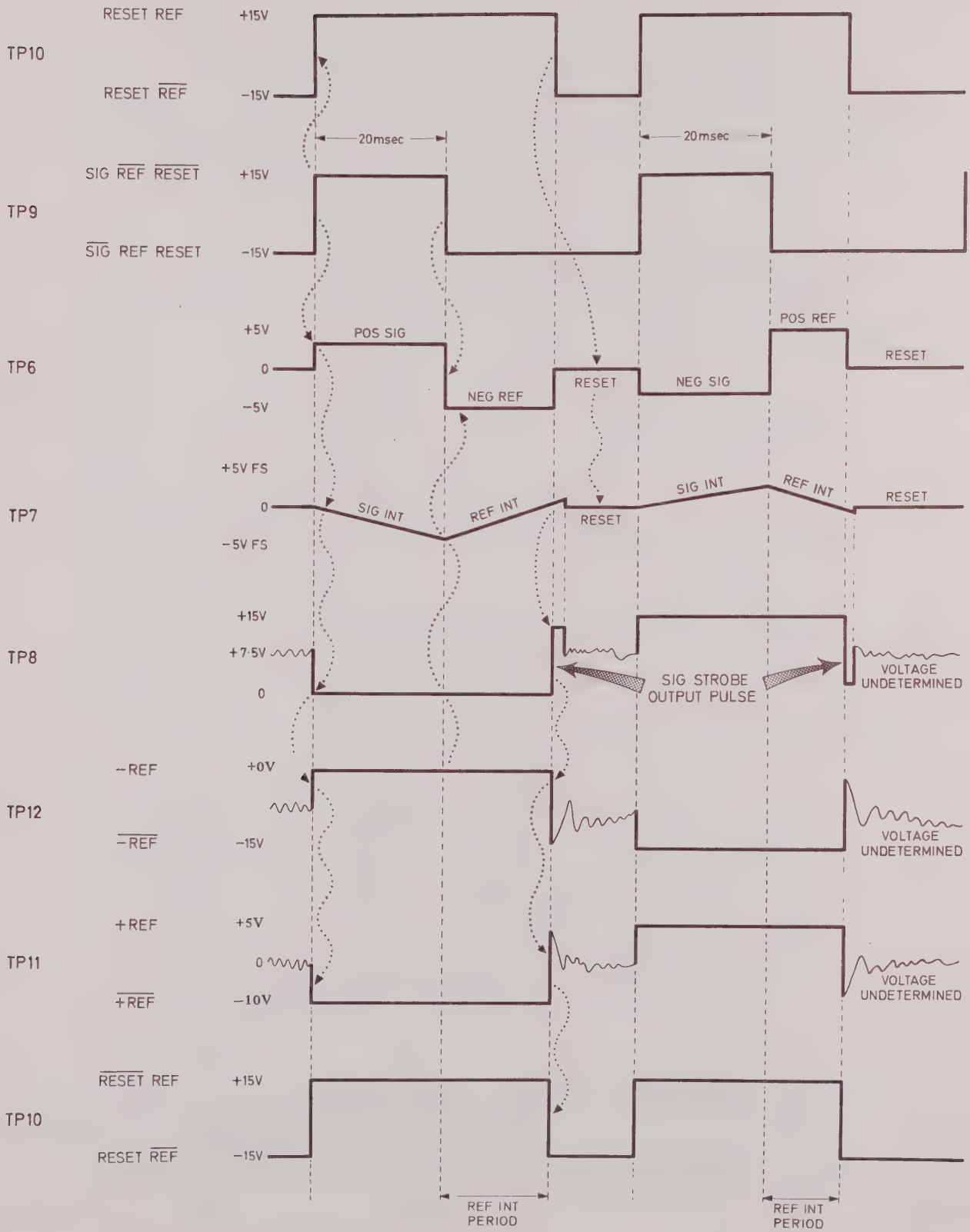


Fig. 5:12 INTEGRATOR TIMING DIAGRAM

5.3.2 Digital Section – Assembly Drawing No. 409120A, Sheet 1

The simplified block diagram given below illustrates the general arrangement of the digital circuitry.

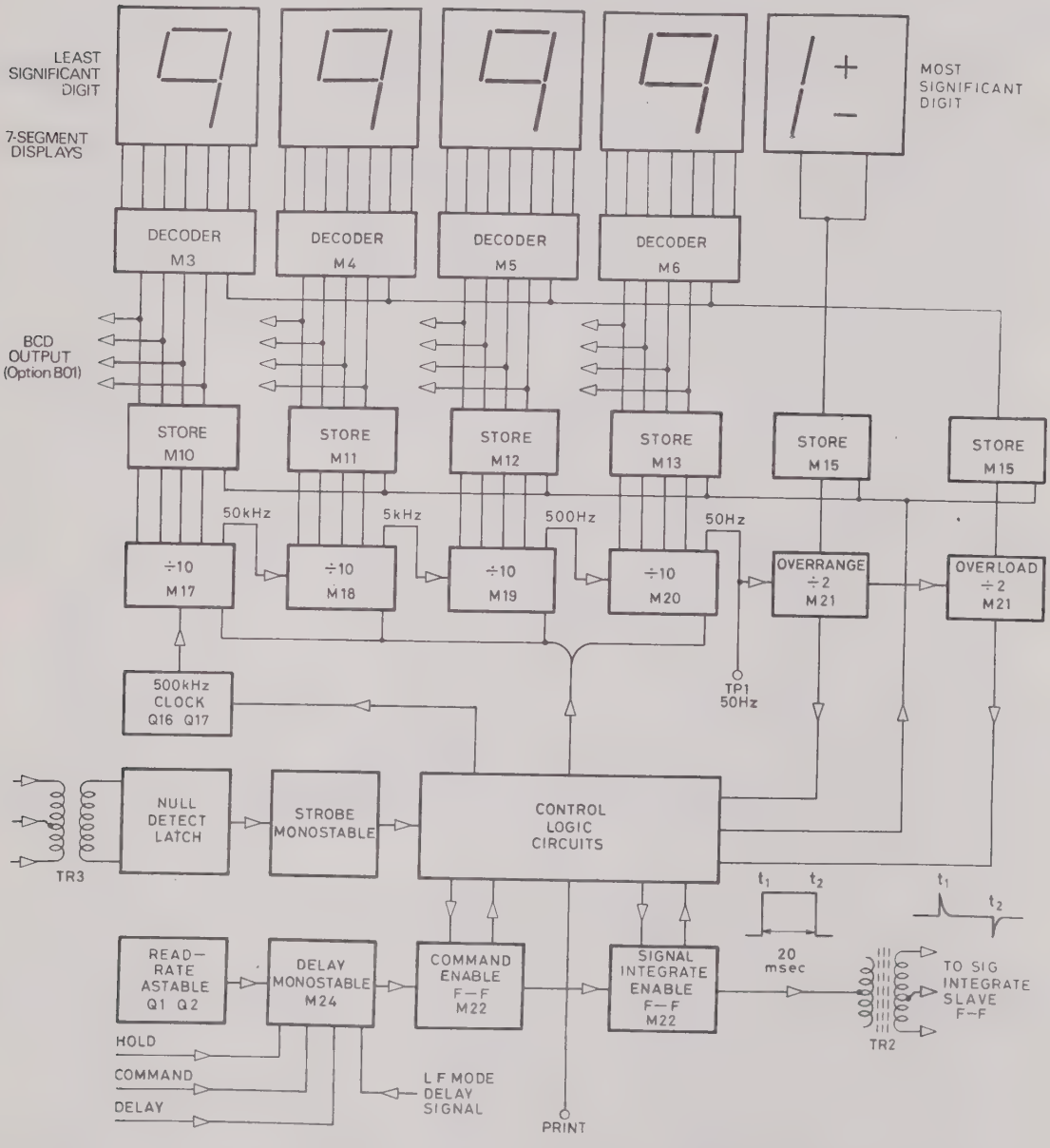


Fig. 5:13 SIMPLIFIED DIAGRAM OF DIGITAL CIRCUIT

The repetition frequency with which digital measurements are made is determined by the Read Rate Astable. Its output is gated to allow HOLD, COMMAND or DELAY to be introduced by the Delay Monostable. DELAY applies to external command only and is only brought into operation by applying a zero to the Delay pin of the BCD connector (Option B01). The appropriate delay period is then automatically selected to allow a delay equal to the settling time of the analogue circuitry, depending upon whether it is switched to NORMAL or FILTER.

At any time following a STROBE pulse from the Null Detector, the Command Enable F-F is in a state to permit a COMMAND to be fed into the Control Logic circuits. Upon receipt of a COMMAND pulse the Control Logic clears the Stores and sets all the decade counters to:-

9 9 9 9 0 1

Note:

In this, and all subsequent explanations, the least significant figure is shown on the left.

Output from the 500 kHz Clock is then admitted to the four cascaded decade counters M17 - M18 - M19 - M20 followed by two binary counters, Overrange and Overload. The first clock pulse admitted to the decade counters changes their state to:-

0 0 0 0 1 0

The change in state of the Overrange binary counter creates a pulse which is fed, via the Control Logic, to the Signal Integrate Enable F-F. This generates the leading edge of a flat-topped pulse at time t_1. After 10 000 clock pulses the Overrange binary counter changes state again when all the digits revert to zero, and:-

	(decimal)	(binary)
	0 0 0 0	1 0
Plus:	0 0 0 0	1
Equals:	0 0 0 0	0 0

Note:

Overload F-F is held in 'Clear' condition during this period.

Signal Integrate Enable returns to its original state at time t_2, having generated a precise SIG. INTEGRATE pulse of exactly 20 msec duration. This pulse determines the signal integration period as explained in Section 5.3.1.

The count (standing at 0 0 0 0 0 0 at time t_2) proceeds in an uninterrupted manner during the REF. INTEGRATE period until the Null Detect Latch operates and (via the Strobe Monostable and Logic Circuitry) stops further clock pulses from reaching the decade counters. At the same moment, the Strobe Monostable pulse is made available as a PRINT command. Depending upon the state of the count at the instant of STROBE, any one of three conditions can occur:-

	(decimal)	(binary)
If less than full-range count:		
The 7-segment displays fed from the decade counters will be illuminated.	X X X X	0 0
If more than full-range count:		
The 7-segment displays fed from the decade counters, plus the overrange figure 1 will be illuminated.	X X X X 1	0
In the event of the count exceeding:	9 9 9 9 1	0
Then the instrument is in the OVERLOAD state and no digits are illuminated.	X X X X	X 1

In the OVERLOAD condition the Control Logic circuits inhibit the Command Enable F-F and the Signal Integrate Enable F–F so that no further counts take place until the overload is removed.

On the following page the above sequence is summarized in tabular form for quick reference, see Fig. 5:14.

COUNTER SEQUENCE SUMMARY

(X = Undefined Digit)

	Least Significant DECADES				BINARY Most Significant	
					Overrange	Overload
Initially	X	X	X	X	X	X
COMMAND sets to (Then starts count)	9	9	9	9	0	0
TIME t_1 (COMMAND +1 clock pulse) Start of SIGNAL INTEGRATE	0	0	0	0	1	0
TIME t_2 (20 msec later) i.e. 10 000 clock pulses End of SIGNAL INTEGRATE Start of REF. INTEGRATE	0	0	0	0	0	0
Null Detects at end of REFERENCE INTEGRATE						
<Full Range	X	X	X	X		0
≥Full Range	X	X	X	X	1	0
Overload	X	X	X	X		1

ILLUMINATED

ILLUMINATED

Fig. 5:14

5.3.3 Display – Assembly Drawing No. 400026

The Display comprises seven segment cold cathode (Beckman – Sperry) enunciators operating from a 180V DC supply line. The complete assembly is mounted on the front of the A –D assembly and at right angles to it. The segment drive lines from the decoder drivers on the A – D pass via the soldered right angle connector directly to the pins on the displays. Decimal points DP2 DP3 and DP4 are also driven directly from the A – D assembly. The remaining decimal point, DP1 the overrange digit and the + and – indicators are driven from high voltage buffer transistors Q8, Q7, Q5, and Q6 mounted on the display board. These transistors are driven from TTL levels. The "V" and "m V" indicators are incandescent long life lamps driven directly by M1 which decodes signals presented by the A – D assembly.

The 180V supply line is operated on the display board by a DC to DC converter stepping up from the 5V supply. The advantages of this method are two-fold, firstly it localises the presence of high voltages and secondly it is automatically regulated since the 5V line is regulated. Transistors Q1 and Q2 form an astable multivibrator driving Q3 which switches one side of the primary of the toroidal transformer T1 to zero volts at an approximate 12KHz rate. The centre-tap connects to +5V via R1 and C1 and the other half of the primary drives CR3 which acts as an efficiency diode giving an overall conversion efficiency of greater than 80%. W1 rectifies the high voltage square wave output, C1 smoothes out any spikes present and R6 and R8 feed the anodes of the display modules DM1 and DM2.

5.3.4 External Reference (Ratio)

Under normal operation the references for the dual slope integrators are provided internally on the A – D P.C.B., and an option is available for using an external reference when required.

The use of an external reference enables ratio measurements of the $V_{DC}/V_{EXT\ REF}$, $V_{AC}/V_{EXT\ REF}$ and $OHMS/V_{EXT\ REF}$ to be made.

Provision is made for switching to an external reference by operating the 'EXT REF' switch on the rear panel and connecting the external reference voltage to the rear panel socket. The external reference may also be selected by the remote programming, pin 7 when the rear panel switch is in the 'INT REF' position. When the external reference has been selected either by rear panel switch or external programming, a logic signal $\overline{EXT\ REF}$ is available at the BCD output socket, pin 25.

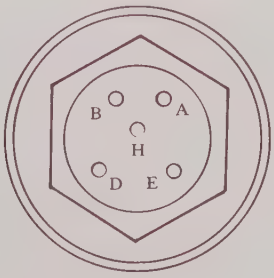
For valid ratio measurements a X5 voltage gain is required between the external voltage reference and the voltage presented to the converter integrator (to match the X5 gain in the signal path provided by M34 on the A –D P.C.B.

The external reference amplifier, the essential features of which are shown in Fig. 5:15, provides X5 gain and presents a high impedance to the external voltage.

Amplifier M1 and M2 are used in the non-inverting configuration producing a high input impedance. Each amplifier has a voltage gain of X3, but 1/3 of the output voltage of each is shared, producing an overall differential voltage gain of 5 at the output of M1 and M2. Amplifier M3 produces a differential input to single ended output conversion and has a voltage gain of X1.

The switching of internal to external reference is achieved using relay K1.

Pin Connections as seen from rear.



E = Input Hi

D = Input Lo

H = Analogue Common

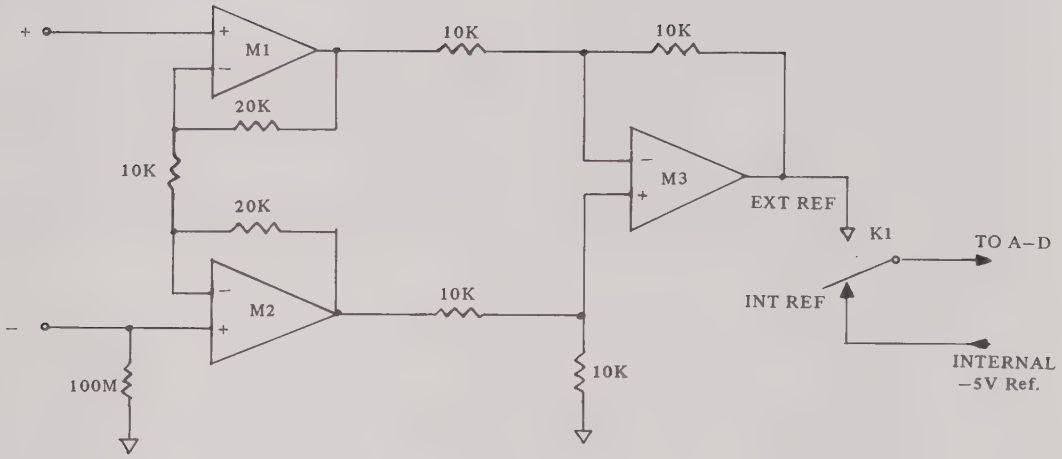


Fig. 5:15 EXTERNAL REFERENCE AMPLIFIER

SECTION 6

SPECIFICATION VERIFICATION

6.1 DESCRIPTION

The following steps form a routine for checking that the instrument is working within its specified accuracy where the intention is not to re-calibrate internally. It is thus useful for incoming inspection or routine calibration checks.

Full internal calibration is described in Section 7, MAINTENANCE. It is recommended that due to the wide measurement capability of the instrument, only those aspects of the specification relevant to normal use be verified. This saves considerably in both time and calibration equipment, especially where the 1 μV resolution or hf AC performance are not required. For general-purpose measurements, the whole procedure should be followed to verify the entire specification. Space is provided to tick against each step checked

6.2 INSTRUMENT REQUIREMENTS (DC)

A DC source is required of accuracy at least three times better than the accuracy being verified, from 10 mV to 1000V.

Examples:

Julie Research DVS 106

Optimation AC 126/PA1182 (For AC and DC)

6.3 PROCEDURE – DC PERFORMANCE

6.3.1 Turn on the instrument to be checked and allow at least one hour, preferably two hours, to warm up.

6.3.2 Switch instrument to 1 volt range. Flick the Local/Remote Guard switch to LOCAL.

6.3.3 Connect Hi to Lo with a short link. Check the instrument reads 0.0000 ± 0.0001.

6.3.4 Apply +1.0000 volts check reading is
+1.0000 ± .0002

6.3.5 Apply –1.0000 volts check reading is
–1.0000 ± .0002

If 6.3.3 to 6.3.5 are passed this indicates that most of the instrument is working correctly. If it is failed by more than 0.3% then it is likely that there is a fault rather than a calibration error.

6.3.6 Select 10V range Apply +10.000V check reading is
+10.000 ± .0002

6.3.7 Apply –10.000V Check reading is
–10.000 ± .0002

6.3.8 Select 100 V range Apply +100.00V check reading is
+100.00 ± .02 V

6.3.9 Apply –100.00V, check reading is
–100.00 ± .02V

6.3.10 Select 1KV range
Apply +1000.0V, check reading is
+1000.0 ± 0.2V

6.3.11 Apply –1000.0V, check reading is
–1000.0 ± 0.2V

6.3.12 Select 10 mV range. Turn DC source down to zero. Allow several minutes for thermal e.m.f.'s to disappear or stabilize.
Adjust mV offset for display of ± 0.000

Apply +10.000 mV, check reading is
+10.000 ± 0.003 mV

6.3.13 Apply –10.000 mV, check reading is
–10.000 ± 0.003 mV

(If changing polarity involves reversing leads, check zero again as thermal e.m.f.'s may have changed. If possible reverse polarity at a higher voltage level so as not to reverse thermals).

6.3.14 Select 100 mV range Apply +100.00 mV, check reading is
+100.00 ± 0.02 mV

6.3.15 Apply –100.00 mV, check reading is
–100.00 ± 0.02 mV

This concludes checking of accuracy.

6.3.16 For linèarity check, select 1 volt range.

Apply +0.1000V, check reading is
+0.100V ± 0.001V

6.3.17 Apply +0.5000V, check reading is
+0.5000 ± 0.00015

6.3.18 Apply +1.000V, check reading is
+1.000 ± .0002

6.3.19 Apply +1.9000V, check reading is
+1.9000 ± .0003

DC Verification is now complete.

6.4 INSTRUMENT REQUIREMENTS (AC)

Optimation AC125/PA1182

Hewlett Packard 745/746

6.5 PROCEDURE AC PERFORMANCE

6.5.1 Carry out 6.3.1 and 6.3.2 and switch to FILTER.

6.5.2 Connect Hi to Lo with a short link. Check instrument reads 0.0002 maximum.

6.5.3 The check readings in the following list will have two limits. The first is for the model 01, the second of wider limits the model 11.

6.5.4 Apply 1.0000 volts at 5 KHz, 20 KHz, 100 KHz in turn. The readings are respectively:

1.0000 ± .0005 (.0014)
1.0000 ± .0010 (.0030)
1.0000 ± .0020 (.0050)

If this test is failed by more than about .3% at 5 KHz or 2% at 100 KHz there is probably a fault rather than a calibration error.

6.5.5 Repeat 6.5.4 for the 10V range with 10V input. The readings are:

10.000 ± .005 (.014)
10.000 ± .010 (.030)
10.000 ± .020 (.050)

6.5.6 Repeat 6.5.4 for the 100V range with 100V input. The readings are:

100.00 ± .05 (.14)
100.00 ± .10 (.30)
100.00 ± .20 (.50)

6.5.7 Repeat 6.5.4 for the 1000V range with 1000 V input except at 100 KHz which is not specified. The readings are:

1000.0 ± 1.2 (1.4)
1000.0 ± 1.7 (3.0)

At 300 V the readings should be:

300.0 ± .3 (.7)
300.0 ± .6 (1.6)

6.5.8 The remaining steps do not apply to the type 11 converter.

6.5.9 Repeat 6.5.4 for the 10 mV range with 10 mV applied. 100 KHz is not applicable to this range. The readings are:

10.000 ± .020
10.000 ± .030

6.5.10 Repeat 6.5.4 for the 100 mV range with 100 mV applied. The readings are:

100.00 ± .05
100.00 ± .10
100.00 ± .20

AC verification is now complete.

6.6 INSTRUMENT REQUIREMENTS (OHMS)

A set of standard resistors is required covering 10 Ω to 10 MΩ. The 10 Ω, and 100 Ω resistors should be 4-wire types.

6.7 PROCEDURE – OHMS PERFORMANCE

6.7.1 Carry out steps 6.3.1 and 6.3.2.

6.7.2 Select 10R, 4-wire: connect the 10R resistor in a 4 terminal measurement.
Check instrument reading is:

10.000 ± .003

6.7.3 Select 100R, 4-wire, connect the 100R resistor in a 4 terminal measurement. Check reading is:

100.00 ± .02

6.7.4 Select 1K, 4-wire. Connect the 1K resistor for 4-wire. Reading is:

1.000 ± .0002

6.7.5 Select 10K 2-wire. Connect the 10K resistor to Hi and Lo. Reading is:

10.000 ± .002

6.7.6 Select 100K, 2-wire. Connect the 100K resistor to Hi and Lo. Reading is:

100.00 ± .02

6.7.7 Select 1M, 2-wire. Connect the 1M resistor to Hi and Lo. Reading is:

1000.0 ± .3

6.7.8 Select 10M, 2-wire. Connect the 10M resistor to Hi and Lo. Reading is:

10000 ± 11

If long unscreened leads are used on the last two measurements, the use of FILTER will reduce the digit jitter, due to 50 Hz pick-up.

If high voltage standard resistors have a guard terminal then connect this to ohms guard.

If all the checks made in Section 6.7 are made, and met, this confirms that the model 1041 is within its calibration specification for resistance.

6.8 INSTRUMENT REQUIREMENTS (EXTERNAL REFERENCE)

A stable DC source of approximately 1V.

A stable DC source of approximately .2V.

6.9 PROCEDURE EXTERNAL REFERENCE

Make sure that the DC signal measurement is working correctly as in Section 6.3. Switch the rear panel slide switch to external reference.

6.9.1 Connect Signal Hi to Reference Hi and Signal Lo to Reference Lo. Switch Guard to Local, and to 1V range. Apply approximately +1V to the commoned signal and reference inputs. The reading is:

1.0000 ± .0002

6.9.2 Repeat 6.9.1 with +0.2 volts. The reading is:

1.0000 ± .0006

If these conditions are met then the external reference performance is functioning correctly.

SECTION 7

MAINTENANCE

7.1 GENERAL

It is strongly recommended that Section 5 – TECHNICAL DESCRIPTION be read before commencing with the adjustment or replacement of component parts of the instrument. The Circuit Diagrams and Components Lists show all the electrical components contained in the instrument, together with their values and significant ratings.

The Instrument uses solid-state devices which, despite their inherent long-term reliability and mechanical ruggedness, are suscepticle to damage by overloading, reversal of polarity and excessive heat or radiation. Avoid hazards such as reversal of DC supply polarity, shorting + ve supply to –ve supply, prolonged soldering, strong r.f. fields or other forms of radiation, the use of high voltage insulation testers or accidently applied short-circuits.

When working on the isolator board, special consideration should be given to the effects of board leakage. Although active guarding is used extensively to reduce these effects, it should be borne in mind that because of the high input impedance and sensitivity involved efforts shall be made to remove all traces of flux after soldering. It is also strongly recommended that a proprietary make of PCB lacquer (such as ELECTROTUBE PCL 2) be used to protect the board surface. Allow at least six hours before for the lacquer to set before using the instrument.

In case of difficulties, or for general advice in servicing your instrument, do not hesitate to write or telephone our Service Department. Always mention the type number and serial number of your instrument. (For the address and telephone number, see the front of this handbook.)

7.2 REMOVAL OF COVERS – ACCESS TO COMPONENTS

Note:

The front-panel terminals are insulated from the instrument case enabling the circuitry to float at potentials greater than earth, therefore the potentials of the internal Guard Shields can reach dangerous levels. Before removing the instrument covers, disconnect both the supply mains and the signal input leads.

Access to the interior of the instrument is gained by removing the four screws securing the top cover, two screws at each side and lifting the cover clear of the instrument. Removal of the bottom cover is achieved in an identical manner. The top cover provides access to the analogue to digital converter, the ratio option and the isolator board. The bottom cover provides access to the AC and Resistance Converter options. It will be noted that with both covers removed, the instrument is still capable of being operational, it may inverted with no danger of component damage, and full mechanical rigidity is maintained during servicing operations.

7.3 SEMICONDUCTOR REPLACEMENT

The necessity for integrated circuit or transistor replacement is unlikely, especially after the burn-in period the unit has received at Datron. Should the necessity arise the semiconductor failure can usually be attributed to component breakdown in the associated circuit.

Several of the integrated circuits are Datron selected devices and in addition the input IC M21 on the isolator board is subjected to a very lengthy high temperature burn-in. All other components however are standard manufacturer's products and selection is unnecessary.

Temperature compensation of the input stage is achieved by direct measurement of drift and selection of appropriate component values to compensate, as described in Section 7.4.2.3 zero drift compensation. This rather time consuming procedure is carried out initially during manufacture and need only be repeated following replacement of M21.

In certain other cases following semiconductor replacement it may be necessary to readjust associated preset components and full details of recalibration (based upon original factory calibration procedures) are given in Section 7.4.

When replacing semiconductor devices take great care to avoid overheating them during soldering . . . each joint being made as rapidly as possible. Although the use of a thermal shunt between semiconductor device and the soldered joint is strongly recommended, it is realised that it is impractical to use one in many instances . . . particularly when unsoldering a multi-lead device from a high density circuit board, a suction de-soldering tool is recommended.

7.4 CALIBRATION PROCEDURES

The following sections form part of the original factory setting-up procedures, for the two printed circuit boards. During manufacture, certain resistors are selected in value (FSV = Factory Selected Value) to accommodate the circuit component tolerances or to bring the desired setting of a preset control to the middle of its adjustment range. As the values of the FSV resistors have already been correctly chosen to suit your instrument, the methods used for their selection have in most instances been omitted. Full details are given for adjusting all the preset components.

IMPORTANT

A small amount of interaction exists between certain controls, also the adjustment of certain controls has an effect which may not be immediately noticeable, i.e. zero drift with temperature. The user is therefore warned **not** to follow blindly all the sequences described, but to read and understand the reason behind each procedure, before embarking upon any actual adjustments on his own account. This approach should minimize the amount of time spent on recalibration, and in a number of instances, will eliminate upsetting preset adjustments which are already correctly set.

7.4.1 Digital Board Assembly – Drawing No. 409120A

7.4.1.1 **Test Equipment Required**: The following test instruments, or their equivalents, are necessary in order to adjust the Digital Board Assembly.

DC Calibration Source: Accuracy 0.003% (or better).
e.g. Julie Research DVS 106

Dual Channel Oscilloscope or Timer
Capable of measuring 20 msec to 0.05% (or better).

7.4.1.2 **Preparation**: Check that the board appears to be in a working condition: locate and repair any faults noticed. Verify that the power supplies are ± 15 V and +5 V, both to 5% accuracy. Allow half an hour warm-up time before proceeding to the next step.

Put the instrument into the HOLD mode, by connecting digital COMMON to the HOLD command line. (Link pins 39 and 40 of the BCD output connector J5 if either of the BCD output Options are provided.) Alternatively, if BCD facilities are not included, turn the instrument OFF and solder a jumper lead between pin 7 LOWER and pin 6 LOWER of connector J4.

7.4.1.3 **Integration Period Calibration**: Sense the TTL pulse waveform on TP1, near M20, and adjust preset potentiometer R37 until the period of the waveform is 20.00 ±0.01 msecs, i.e. 50 Hz.

In the U.S.A. and other countries where the supply-mains frequency is other than 50 Hz, the waveform period is set to the nominal mains period. Thus, in the U.S.A. set to 16.67 ±0.01 msecs, i.e. 60 Hz.

A time interval counter may be used for this procedure or, alternatively, connect TP1 to the A Channel of the dual trace oscilloscope. Set the Y sensitivity to about 5 V/division, and trigger the timebase from this channel. Set the timebase to 10 msec/division. Connect a source of mains supply frequency (simple hum pick-up at a high sensitivity is adequate) to the B Channel, so that the 50 (or 60) Hz waveform is about 2 divisions p-p high on the screen. If the oscilloscope is dual-trace rather than double-beam, switch the

R37 time base to CHOP rather than ALTERNATE mode, and adjust R37 until both traces are the same frequency. (Both traces stationary with respect to each other, or less than one period drift in 20 seconds.) It is important, when using this procedure, that the supply-mains frequency is close to nominal and, for this reason, it should not be carried out at times of peak load, particularly in winter. Having adjusted R37, disconnect the oscilloscope probes, etc.

7.4.1.4 **Zero Calibration**: Remove the hold link and allow the instrument to free run. Short together the SIGNAL COMMON, ANALOGUE COMMON and SIGNAL INPUT pins. Set R75 to its mid position and connect the DVM or Null Detector between TP3 and ANALOGUE COMMON. Select a ¼ watt carbon FSV resistor for either R69 or R70 to reduce the offset to less than ±100 μV. Solder the resistor

R75 into the terminals. Adjust R75 to reduce the offset voltage on TP3 to less than ±10 μV. It is now necessary to adjust the integrator zero to be near zero by selecting a ¼ watt carbon resistor for either R104 or R105. Select the appropriate standard value resistor to bring the display to as near bouncing polarity as possible. This is not critical and it should be noted that since the digital zero has not been set then any reading on

R75 the display (other than the polarity signs) should be ignored. Readjust R75 for bouncing polarity signs.

7.4.1.5 **Digital Zero Calibration**: Remove the shorting link from between SIGNAL INPUT and SIGNAL COMMON but leave SIGNAL COMMON and ANALOGUE COMMON shorted. Apply +1.7 digits (170 μV) between

R106 SIGNAL and SIGNAL COMMON and adjust R106 for a display bouncing between +0001 and +0002. Apply –170 μV and check that display reads –0001 or –0002.

7.4.1.6 **Full Scale Calibration**: Adjust the DC Calibration Source to +.99995 volts and, turn R86 to its centre position. Select a metal film 50 ppm ¼ watt FSV resistor, R87, to bring the reading to between 9980 and 10010. If necessary a ¼ watt carbon resistor may be used in parallel with the Metal film provided its value is at least ten times that of the Metal film, i.e. the Metal film may only reduce the reading to 1.0100 and a carbon resistor finally reduces the reading to the limits specified above. Solder in the FSV resistors.

R86 With +.99995 volts still applied adjust R86 until the display bounces between 9999 and 10000. Apply

R95 –.99995 volts and adjust R95 until the display bounces between –9999 and –10000.

7.4.1.7 **Linearity and Display Check**: Leaving the DC calibration connected set it to the following output levels and observe the displayed readings:-

Set Calibrator to	1.9999 volts
and observe reading	19999
Set Calibrator to	1.8888 volts
and observe reading	18888

Repeat the above for all digits down to 11111 then 1111, 0111, 0011, 0001, 0000. Linearity on all steps should be within 1 digit.

7.4.1.8 **Overload Check**: Check that display blanks out as soon as the input voltage exceeds 1.9999 volts.

7.4.2 **DC Isolator Board Assembly – Assembly Drawing No. 400035**

7.4.2.1 Equipment Required

1. Precision DC Source capable of 0.002% ±1 microvolt accuracy over the range 10 mV to 1000V e.g. DVS 106.
2. Full calibrated DVM such as a Datron 1041 or 1045 or the A – D converter assembly which pairs with the isolator assembly being calibrated
3. A fully floating null detector capable of resolving ± 10μV.

7.4.2.2 Zero Drift Compensation and Zero Adjustment

This procedure need only be carried out following replacement of M21.

1. Fit Lower Guard Shield.
2. Connect a link between TP1 and SIGNAL COMMON to short the input of M21.
3. Select 10 mV DC.
4. Connect a 10 μV resolution DVM or null detector to the output of M21 (TP2). Centralise the mV offset potentiometer R75. Using the FSV resistor R16 or R17, zero the output of M21 (R16 and R17 should be 50ppm metal film resistors if they are less than 1 MΩ in value – good quality carbon resistors suffice at higher values). DO NOT SOLDER IN.
5. Switch to 10V range.
6. Adjust R74 to bring the Bootstrap voltage (BS) to 0 ± 20 μV.
7. Adjust R73 to bring the output voltage (TP3) to 0 ±10 μV.
8. Return to 10 mV range and remove between TP1 and SIGNAL COMMON. Replace the link with a 10 MΩ resistor and adjust R65 (Current compensation) to achieve an output on TP3 of less than 10 mV.
9. Remove the 10 MΩ resistor and short together signal end of R1 and SIGNAL COMMON [Or the input terminals if connected at this stage] and leave to stabilise thermally.
10. Adjust R75 for zero output [± 100 μV] on TP3. Place instrument in an oven set at approximately 50°C.
11. After approximately 1 hour, note direction and magnitude of the output drift on TP3 and if this is greater than 1 mV compensation is required.
12. Compensation is achieved by adjusting R16 and R17 to produce an offset in the opposite direction to the drift observed in 11. The magnitude of this offset should be about five times the magnitude of the drift.
13. Repeat operations 11 and 12 until the drift in step 11 is less than 1 mV.
14. In general, after cooling, there will be a fixed offset which must be zero'ed without effecting the temperature compensation. This is achieved by selecting a link between R10 and +BS or –BS and selecting R10 and R11 to reduce the offset to zero ± 10 μV with R75 in the centre of its span.

7.4.2.3 Primary Calibration

R75 1. Switch to 10 mV, Filter and short input. Adjust R75 for zero offset.

R73 2. Switch to 1V range and adjust R73 for zero output offset on TP3.

R69 3. Apply 1.0000V and connect the null detector between the input voltage Hi and TP3. Adjust R69 for zero reading (± 10 μV) on the null detector.

R70 4. With the voltmeter or A – D converter connected to TP3 switch to the 10V range and apply 10.0005 V. Adjust R70 for 1.0000 bouncing to 1.0001.

R71 5. 100V range, 100.005V input, adjust R71 for a reading as in step 4.

R72 6. 1000V range, 1000.05 mV input, adjust R72 for reading as in step 4.

R67 7. 100 mV range, 100.005 mV input, adjust R67 for reading as in step 4.

R68 8. 10 mV range, 10.0005 mV input, adjust R68 for reading as in step 4. Note that due to thermal E.M.F.'s it may be necessary to repeatedly reverse polarity and calibrate for a total span of 20.001mV e.g. +9.999 and –10.001 mV.

7.4.3 AC Converter – Assembly Drawing Number 400037

7.4.3.1 Equipment Required

1. Precision AC Source capable of 0.02% accuracy at LF and 0.05% at 100 kHz. Ranges 10 mV to 1000V.
2. 1041 DC isolator or special test box in which to plug the converter.
3. DC voltmeter capable of 1μV resolution e.g. Datron 1041 or 1045.

7.4.3.2 Zero drift compensation and adjustment

The following procedure (steps 1 to 7) is only necessary following replacement of Q6 or M1. Steps 8 to 14 are normal calibration steps but reselection of F.S.U. resistors is unlikely unless integrated circuits have been replaced.

1. Short-circuit the input and switch to 10V range. Connect a DVM on its 100 mV range between TP3 and Common.
2. Observe that the reading is less than 10 mV, if not, M1 must be replaced.
3. Touch soldering iron (mains and earth isolated as Weller TCP1) to top of M1 for about 15 seconds and check that M1 is not too hot to touch, i.e. about 50°C. Observe the direction and magnitude of the drift from the reading in step 2.
4. Select F.S.V. resistors R51 or R52 such that they introduce an offset in the opposite direction to the observed directi on of drift, about 1 mV per 100 μV of observed drift.
5. Allow to cool and repeat steps 2 to 4 until the drift is less than about 100μV. Check that the final offset is less than ± 15 mV.
6. Connect the DVM between common and TP4 and repeat the soldering iron procedure, heating Q6 and selecting R41 or R42 until the drift is less than 100 μV.
7. Set R36 to the centre of its span and select F.S.V. resistor R34 or R35 to reduce the output on TP4 to within 1 mV of zero. Recheck and if necessary repeat steps 6 and 7 until the drift is low and the offset zero.
8. Connect an oscilloscope to TP6 and adjust R36 for zero indication. This will be noisy due to the high gain of the rectifier circuit.
9. Connect an oscilloscope to TP7 and adjust R98 for an indication of about –500 mV (this will be noisy). If necessary F.S.V. resistors R101 or R102 may be used to extend the range of adjustment of the potentiometer.
10. Adjust R98 until TP7 is about 200 mV positive. Install but do not solder a F.S.V. resistor of about 680 kΩ for R117 . Centralise R109 and observe the voltage on TP10 relative to Common. Select F.S.V. resistors R111 or R112 to zero the voltage on TP10 to ± 500 μV. [typical value 3M9]. Adjust R109 to give –300 μV on TP10 .
11. Centralise R115 and remove the 680 kΩ resistor. Select F.S.U. resistors R117 or R118 to just allow low frequency oscillation on TP10. Adjust R115 until oscillation JUST stops.
12. Solder in the FSV resistors and adjust R109 for zero ± 20 μV on TP10.
13. Adjust R98 for about –500 μV (noisy) on TP7. Zero calibration is now complete.
14. Centralise R16 and R67, apply 1V 400 Hz and select Metal film FSV R66 to give 1·0000V ± 300 μV.

7.4.3.3 Primary Calibration AC

1. Fit the guard shield and allow the converter to stabilise thermally.
2. Centralise R67, R16, R18, R22, R26, R9, C13, C14, C18, C20, C6, R70, R61.

R16 **R98**
3. Apply 1·0000V 400 Hz and switch to 1V AC filtered. Adjust R16 for an output of 1·0000 ± ·0001 volts DC. Reduce to 1 μV and calibrate R98 for 10 digits.

R61
4. Apply a defined high crest factor (5:1) assymmetrical signal such as a 25:1 mark space pulse train. Note output when pulses are –ve going at input. Reverse the input and adjust R61 for an identical reading with +ve going pulses.

R70
5. Calibrate the high crest factor signal using R70. Recheck step 3 and repeat calibration of R70.

R18
6. Apply 10V 400 Hz, 10V range. Calibrate output to ± 1 digit using R18.

R9
7. Apply 100V 400 Hz, 100V range. Calibrate output to ± 1 digit using R9.

R22 8. Apply 10 mV, 400 Hz, 10 mV range. Calibrate output to ± 1 digit using R22

R26 9. Apply 100 mV, 400 Hz, 100 mV range. Calibrate output to ± 1 digit using R26.

C13 10. Return to 1V range and apply 1.0000V, 40 kHz. Adjust C13 to calibrate the output ± 2 digits.

C15 11. Switch to 10V range and apply 10.000V, 40 kHz. Adjust C15 to calibrate the output ± 2 digits.

12. Reduce frequency to 10 kHz and check that the reading is within ± 2 digits of nominal. If not it will be necessary to move the wire joining R4 and R5, making it more "earthy" will bring down the reading at 10 kHz. Repeat step 11.

13. Return to 1V range and repeat step 10. Reduce the frequency to 10 kHz and adjust twisted pair capacitor C55 to bring output within 2 digits of nominal (closer coupling will increase the reading). This can be fine adjusted without removing the guard shield by "unpicking" the twisted pair with a screwdriver through the guard shield holes. Repeat step 10 and recheck.

14. Repeat step 11.

C6 15. Switch to 100V range and apply 100V, 40 kHz. Adjust C6 for nominal output ± 2 digits.

C 16. Reduce frequency to 10 kHz and adjust twisted pair capacitor C56 in a similar manner to step 13 except that closer coupling will reduce the reading. Repeat steps 15 and 16 until satisfactory.

C18 17. Switch to 10 mV range, apply 10 mV, 20 kHz and adjust C18 to produce as near nominal output as possible. Vary the frequency over 10 kHz to 30 kHz and adjust for best flatness at nominal output.

C20 18. Switch to 100 mV range apply 100 mV, 40 kHz and adjust C20 for nominal output ± 2 digits.

The AC Converter is now calibrated. Note that steps 8, 9, 17 and 18 do not apply to Option 11.

7.4.4 Resistance Converter – Assembly Drawing Number 400036

7.4.4.1 Set of precision resistors covering 10Ω to 10 MΩ, the 10Ω, 100Ω and 1 kΩ to be 4-terminal resistors. Calibrated accuracy 0.001% up to 1 MΩ, 0.01% at 10 MΩ. Voltmeter with 1μV resolution e.g. Datron 1041, 1045.

7.4.4.2 **Calibration Procedure OHMS**

Steps 3 and 4 are only necessary following replacement of M3.

1. Install Converter assembly in DVM, switch to 4-wire and short together I+, Hi and Lo terminals and connect to TP4. With the DVM sense the DC isolator output TP5 on the isolator with the DVM on its 10 mV range.

R55 2. Adjust R55 for zero reading on DVM ± 3 μV.

3. Touch soldering iron to M3 for about 3 seconds, wait 15 seconds and check that M3 is not too hot to touch, i.e. is about 50°C. Observe any change in DVM reading and if greater than 20 μV inject

R55 an offset in the opposite direction to the drift and about five times its magnitude by adjusting R55. After cooling repeat the procedure until the drift is less than 20 μV. Note the offset.

R16 & R17 4. Centralise R55 and use F.S.V. resistors R16 and R17 to inject an offset equal to that noted at the end of step 3. Fine adjust with R55 to give exactly that offset.

R18 & R19 5. Select F.S.V. resistors R18 and R19 to reduce the offset to zero ± 100 μV. Readjust R55 for exactly zero.

R59 6. Disconnect TP4 and adjust R59 for zero reading on the DVM.

7. 4-wire connect the 100Ω resistor and connect I– to TP3.

R50 8. Adjust R50 to calibrate to nominal reading ± ½ digit. (100Ω range).

R49 9. Remove link to TP3 and repeat the above step but using R49.

10. Check step 8, replace guard shield.

1 kΩ Range.

R52 11. 4-wire connect a 1 kΩ resistor and calibrate to ± ½ digit using R52.

10 kΩ Range

R53 12. 4-wire connect a 10 kΩ resistor and calibrate to ± ½ digit using R53.

100 kΩ Range

R54 13. Switch to 2-wire and connect a 100 kΩ resistor between Hi and Lo. Calibrate to ± ½ digit using R54.

1 MΩ Range

R51 14. Connect a 1 MΩ resistor between Hi and Lo and calibrate to ± ½ digit using R51.

10 MΩRange

R59 15. Connect a 10 MΩ resistor between Hi and Lo and calibrate to ± 3 digits using R59.

16. Repeat step 14 and then step 15.

Resistance Calibration is now complete.

7.4.5 External Reference – Assembly Drawing No. 400076

Equipment Required.

10 μV resolution DVM e.g. Datron 1041 or 1045.

DC Calibration Source: Accuracy ·003% e.g. DVS 106.

7.4.5.1 Procedure for External Reference

1. Preliminary Check

1.1 S/C the external reference input terminals together and to analogue common.
Set all pots to mid-travel.

1.2 Switch on the machine and allow to stabilise.

1.3 Check that voltage at TP3 is < 20 mV.

1.4 Connect approximately 1V between input terminals and observe X5 (± 1%) the input voltage on TP3.

1.5 S/C the input and to analogue common again.

1.6 Connect the M2 side of R5 F.S.V. terminal to analogue common and F.S.V. M1 to obtain < ± 100 μV at TP1.

1.7 Connect the M1 side of R5 F.S.V. terminal to analogue common and F.S.V M2 to obtain < ± 100 μV at TP2.

1.8 Discard the connection from R5 to analogue common and by successive adjustments of R11 and R14 produce ± 50 μV at TP1 and TP2.

1.9 F.S.V. M3 starting with 5M6 for R20 to produce <± 10 μV at TP3.

1.10 Solder in F.S.V. resistors.

2. Final Check

2.1 Note the voltage at TP3.

2.2 Remove the connection between the S/C I/P terminals and analogue common and connect to approximately +10V.
Adjust R18 to restore the voltage at TP3 to within ± 100 μV of original reading. (i.e. 100db common mode rejection rate)

2.3 Remove +10V from S/C inputs and connect back to 0V, observe that the voltage at TP3 is still ± 10μV of original reading.

2.4 With switch to INT REF check the digital board calibration for positive I/P after, of course, having allowed the machine time to stabilise with covers on.

2.5 Connect a +1.2V voltage source simultaneously to the signal I/P and ext ref I/P.

2.6 Switch to EXT REF.
F.S.V. R5 (4M7) with R6 at mid-travel to produce +1.000 ± 1 digit on display.

2.7 Adjust the voltage source to +0.2V.
Adjust R21 to produce +1.000 ± 3 digits on display.

2.8 Return the voltage source to +1.2V and adjust R6 to produce +1.0000V on display.

2.9 Repeat paras. 2.9 and 2.10 until no further adjustments become necessary.

2.10 Reverse the polarity of the voltage source to the signal input only.

2.11 Set voltage source to 0.2V.
Adjust R98 on digital board to produce −1.0000 ± 3 digits on display.

2.12 Set voltage source to 1.2V.
Adjust R95 on digital board to produce −1.0000 on display.

2.13 Repeat paras. 2.13 and 2.14 until no further adjustments become necessary.

2.14 Check paras. 2.9 to 2.14.

2.15 Check the calibration of the digital board when switched to INT REF, Section 7.4.1.

7.4.6 Overall Final Calibration

Sections 7.4.1 to 7.4.6 should be carried out for overall final calibration but F.S.V. resistors need not be changed nor any adjustments made that requires removal of guard shield. All trim adjustments should be made as quickly as possible and in the order described. Operate the instrument in its normal operating position as much as possible and remove the lids for as short a time as possible, and replace loosely after each adjustment. Calibration of the AC and Resistance converters should be carried out with the instrument turned upside down. Two hours warm up at 23°C ambient (or as near as possible) with both covers in place should be given before commencing the final calibration.

SECTION 8

OTHER OPTIONS

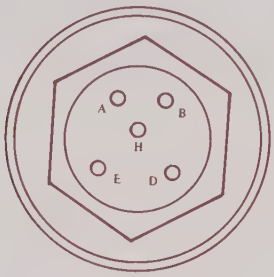
8.1 ANALOGUE O/P

The analogue output is presented from the rear panel via a 5-pin M series connector. A fast-acting fuse is included in both the Hi and Lo side. It is a 1V full range output for any nominal full range input, with overrange capability to 2V. The output impedance is in the order of a few ohms and no more than 5 mA should be demanded.

Pin Connections as seen from rear.

A = Output Hi

B = Output Lo



8.2 Occasionally it may be more convenient for a user to apply his signal input via the rear rather than the front panel.

Pin Connections as seen from rear.

A = Ω Guard

B =

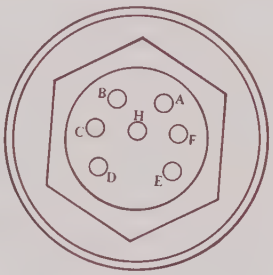
C = I+

D = Input Hi

E = Input Lo

F = I–

H = Guard



A 7 pin M series connector is provided, and should be carefully wired since a high voltage may be present.

When using rear inputs care should be taken as the input voltage will still be present at the front panel terminals. This could be hazardous.

R1 - R4	003 223	22K 5% 2W Carbon			4
R5	000 823	82K 5% ¼W Carbon	Mullard	CR25	2
R6	011 002	10K 1% ⅛W MF	Welwyn	4033C	5
R7	011 004	1M 1% ⅛W MF	Welwyn	4033C	1
R8	000 103	10K 5% ¼W Carbon	Mullard	CR25	48
R9	011 001	1K 1% ⅛W MF	Welwyn	4033C	1
R10 - R11	440 024	F.S.V. 1-10M 1% MF	Welwyn	4033C	2 of Kit
R12	000 476	47M 10% ¼W Carbon	Allen Bradley	CB4761	3
R13	000 824	820K 5% ¼W Carbon	Mullard	CR25	1
R14	000 683	68K 5% ¼W Carbon	Mullard	CR25	8
R15	000 106	10M 10% ¼W Carbon	Mullard	CR25	3
R16 - R17	440 023	F.S.V. (100K 1% MF)	Welwyn	4033C	2 of Kit
R18 - R19	000 105	1M 5% ¼W Carbon	Mullard	CR25	8
R20	000 562	5K6 5% ¼W Carbon	Mullard	CR25	2
R21	070 012	20K 0.1% WW	Mann	M250	3
R22	070 013	2K4 0.1% WW	Mann	M250	1
R23	016 800	68R 1% ⅛W MF	Welwyn	4033C	1
R24	070 014	2K2 0.1% WW	Mann	M250	2
R25	070 012	20K 0.1% WW	Mann	M250	-
R26	000 823	82K 5% ¼W Carbon	Mullard	CR25	-
R27	000 912	9K1 5% ¼W Carbon	Mullard	CR25	1
R28	000 202	2K 5% ¼W Carbon	Mullard	CR25	3
R29	000 105	1M 5% ¼W Carbon	Mullard	CR25	-

NOTES.

DATE. 29/10/74	datron ELECTRONICS LTD.
DRAWN BY.	TITLE 1041 DC ISOLATOR
CHECK	
NEXT DRAWING Mod 2	DRAWING NUMBER 400035 SHEET OF 2 12

	PART No.		MANUFACTURER	PART No.	Per Assy.
R30	000 106	10M 10% ¼W Carbon	Mullard	CR25	-
R31 - R32	000 105	1M 5% ¼W Carbon	Mullard	CR25	-
R33	070 012	20K 0.1% WW	Mann	M250	-
R34	070 014	2K2 0.1% WW	Mann	M250	-
R35	000 202	2K 5% ¼W Carbon	Mullard	CR25	-
R36	000 107	10M 10% ¼W Carbon	Mullard	CR25	-
R37	000 103	10K 5% ¼W Carbon	Mullard	CR25	-
R38	000 202	2K 5% ¼W Carbon	Mullard	CR25	-
R39	000 105	1M 5% ¼W Carbon	Mullard	CR25	-
R40	000 336	33M 10% ¼W Carbon	Mullard	CR25	1
R41	014 702	47K 1% ⅛W MF	Welwyn	4033C	1
R42 - R45	011 002	10K 1% ⅛W MF	Welwyn	4033C	-
R46 - R47	000 103	10K 5% ¼W Carbon	Mullard	CR25	-
R48 - R49	000 683	68K 5% ¼W Carbon	Mullard	CR25	-
R50 - R51	000 273	27K 5% ¼W Carbon	Mullard	CR25	2
R52 - R53	000 100	10R 5% ¼W Carbon	Mullard	CR25	2
R54 - R55	000 104	100K 5% ¼W Carbon	Mullard	CR25	33
R56	000 102	1K 5% ¼W Carbon	Mullard	CR25	5
R57	090 006	9M9) Matched	Allen Bradley		1
R60	090 006	100K) Network			
R61	000 476	47M 10% ¼W Carbon	Allen Bradley	CB4761	-
R62 - R63	000 105	1M 5% ¼W Carbon	Mullard	CR25	-
R64	000 363	36K 5% ¼W Carbon	Mullard	CR25	1

NOTES.

DATE. 29/10/74	datron ELECTRONICS LTD.
DRAWN BY.	TITLE 1041 DC.ISOLATOR
CHECK	
NEXT DRAWING Mod. 2	DRAWING NUMBER 400035
	SHEET 3 OF 12

	PART No.				
R65	063 104	100K Pot. Cermet	Beckman	72P	2
R66					
R67 - R68	063 100	10R Pot. Cermet	Beckman	72P	3
R69	063 500	50R Pot. Cermet	Beckman	72P	1
R70	063 100	10R Pot. Cermet	Beckman	72P	-
R71 - R72	063 501	500R Pot. Cermet	Beckman	72P	2
R73	063 205	2M Pot. Cermet	Beckman	72P	1
R74	063 104	100K Pot. Cermet	Beckman	72P	-
R75	064 105	1M Pot.10 turn Cermet	Beckman	89P	1
R76 - R77	000 102	1K 5% ¼W Carbon	Mullard	CR25	-
R78 - R79	000 123	12K 5% ¼W Carbon	Mullard	CR25	2
R80	000 562	5K6 5% ¼W Carbon	Mullard	CR25	-
R81 - R82	000 107	100M 10% ¼W Carbon	Allen Bradley	CB1071	2
R85	000 476	47M 10% ¼W Carbon	Allen Bradley	CB4761	-
R86	000 103	10K 5% ¼W Carbon	Mullard	CR25	-

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	PART No.					MANUFACTURER	PART No.	Per Assy.
R101 - R108	000 473	47K	5%	¼W	Carbon	Mullard	CR25	43
R109 - R111	000 152	1K5	5%	¼W	Carbon	Mullard	CR25	6
R112	000 473	47K	5%	¼W	Carbon	Mullard	CR25	-
R113	000 103	10K	5%	¼W	Carbon	Mullard	CR25	-
R114	000 473	47K	5%	¼W	Carbon	Mullard	CR25	-
R115	000 103	10K	5%	¼W	Carbon	Mullard	CR25	-
R116	000 473	47K	5%	¼W	Carbon	Mullard	CR25	-
R117	000 103	10K	5%	¼W	Carbon	Mullard	CR25	-
R118 - R120	000 473	47K	5%	¼W	Carbon	Mullard	CR25	-
R121 - R122	000 103	10K	5%	¼W	Carbon	Mullard	CR25	-
R123	000 473	47K	5%	¼W	Carbon	Mullard	CR25	-
R124	000 103	10K	5%	¼W	Carbon	Mullard	CR25	-
R125	000 473	47K	5%	¼W	Carbon	Mullard	CR25	-
R126 - R128	000 152	1K5	5%	¼W	Carbon	Mullard	CR25	-
R129	000 103	10K	5%	¼W	Carbon	Mullard	CR25	-
R130 - R131	000 473	47K	5%	¼W	Carbon	Mullard	CR25	-
R132	000 103	10K	5%	¼W	Carbon	Mullard	CR25	-
R133	000 473	47K	5%	¼W	Carbon	Mullard	CR25	-
R134	000 103	10K	5%	¼W	Carbon	Mullard	CR25	-
R135 - R136	000 473	47K	5%	¼W	Carbon	Mullard	CR25	-
R137	000 103	10K	5%	¼W	Carbon	Mullard	CR25	-
R138 - R139	000 473	47K	5%	¼W	Carbon	Mullard	CR25	-
R140	000 103	10K	5%	¼W	Carbon	Mullard	CR25	-

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R141	000 473	47K 5% ¼W Carbon	Mullard	CR25	-
R142	000 103	10K 5% ¼W Carbon	Mullard	CR25	-
R143 - R146	000 473	47K 5% ¼W Carbon	Mullard	CR25	-
R147 - R148	000 103	10K 5% ¼W Carbon	Mullard	CR25	-
R149 - R157	000 473	47K 5% ¼W Carbon	Mullard	CR25	-
R158	000 103	10K 5% ¼W Carbon	Mullard	CR25	-
R159 - R160	000 473	47K 5% ¼W Carbon	Mullard	CR25	-
R161 - R171	000 103	10K 5% ¼W Carbon	Mullard	CR25	-
R172 - R177	000 104	100K 5% ¼W Carbon	Mullard	CR25	-
R178 - R179	000 103	10K 5% ¼W Carbon	Mullard	CR25	-
R180 - R184	000 104	100K 5% ¼W Carbon	Mullard	CR25	-
R185	000 103	10K 5% ¼W Carbon	Mullard	CR25	-
R186 - R189	000 683	68K 5% ¼W Carbon	Mullard	CR25	-
R190 - R192	000 104	100K 5% ¼W Carbon	Mullard	CR25	-
R193	000 103	10K 5% ¼W Carbon	Mullard	CR25	-
R194 - R196	000 104	100K 5% ¼W Carbon	Mullard	CR25	-
R197 - R199	000 103	10K 5% ¼W Carbon	Mullard	CR25	-
R200	000 683	68K 5% ¼W Carbon	Mullard	CR25	-
R201	000 103	10K 5% ¼W Carbon	Mullard	CR25	-
R202	000 104	100K 5% ¼W Carbon	Mullard	CR25	-
R203	000 103	10K 5% ¼W Carbon	Mullard	CR25	-
R204	000 104	100K 5% ¼W Carbon	Mullard	CR25	-
R205	000 103	10K 5% ¼W Carbon	Mullard	CR25	-

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	PART No.					MANUFACTURER	PART No.	Per Assy.
R206	000 473	47K	5%	¼W	Carbon	Mullard	CR25	-
R207	000 103	10K	5%	¼W	Carbon	Mullard	CR25	-
R208	000 104	100K	5%	¼W	Carbon	Mullard	CR25	-
R209	000 103	10K	5%	¼W	Carbon	Mullard	CR25	-
R210	000 473	47K	5%	¼W	Carbon	Mullard	CR25	-
R211 - R213	000 104	100K	5%	¼W	Carbon	Mullard	CR25	-
R214 - R216	000 103	10K	5%	¼W	Carbon	Mullard	CR25	-
R217 - R222	000 104	100K	5%	¼W	Carbon	Mullard	CR25	-
R223 - R224	000 102	1K	5%	¼W	Carbon	Mullard	CR25	-
R225 - R226	000 275	2M7	10%	¼W	Carbon	Mullard	CR25	2
R227 - R229	000 474	470K	5%	¼W	Carbon	Mullard	CR25	3
R230 - R231	000 103	10K	5%	¼W	Carbon	Mullard	CR25	-
R232	000 475	4M7	10%	¼W	Carbon	Mullard	CR25	1
R233	000 223	22K	5%	¼W	Carbon	Mullard	CR25	1
R234	000 473	47K	5%	¼W	Carbon	Mullard	CR25	-
R235 - R236	000 104	100K	5%	¼W	Carbon	Mullard	CR25	-

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	PART No.		MANUFACTURER	PART No.	Per Assy.
C1 - C2	150 001	22mF 16V Tant	Union Carbide		2
C3 - C4	180 006	47mF 25V Al. Elect	Mullard	016-16479	2
C5 - C6	180 007	15mF 40V Al. Elect	Mullard	015-17159	2
C7 - C8	180 017	220mF 25V Al. Elect	Mullard	017-16221	2
C9 - C10	101 103	0.01mF Cer. Disc	Erie	831	17
C11 - C12	102 330	33pF Cer. Disc	Erie	831	2
C13	102 228	2.2pF Cer. Disc	Erie	831	1
C14	140 003	0.047mF 10% Polyprop.	Wima	MKP10	1
C15	102 471	470pF Cer. Disc	Erie	831	3
C16	120 002	2.2mF 10% Polycarb.	Advance	MR30A	1
C17	140 006	0.33mF 10% Polyprop.	Wima	MKP10	1
C18	140 005	0.15mF 10% Polyprop.	Wima	MKP10	2
C19	140 004	0.068mF 10% Polyprop.	Wima	MKP10	1
C20	101 103	0.01mF Cer. Disc	Erie	831	-
C21	110 002	0.15mF 10% Polyester	Mullard	C280 AE P150K	1
C22 - C23	102 471	470pF Cer. Disc	Erie	831	-
C24	120 004	0.68mF 10% Polycarb.	Advance	MD15A	1
C25	120 006	0.47mF 10% Polycarb.	Advance	MR10A	1
C26	140 005	0.15mF 10% Polyprop.	Wima	MKP10	-
C27					
C28					
C29					
C30 - C33	101 103	0.01mF Cer. Disc	Erie	831	-

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	PART No.		MANUFACTURER	PART No.	Per Assy.
C34 - C35	180 010	33mF 6V3 Al. Elect.	Mullard	015-13339	2
C36	101 103	0.01mF Cer. Disc	Erie	831	-
C37	110 017	0.022mF 10% Polyester.	Mullard	C280 AE P22K	1
C38 - C46	101 103	0.01mF Cer. Disc	Erie	831	-
CR1 - CR6	200 001	Diode Si G.P.	Fairchild/Mullard	IN4148	66
CR7 - CR11	200 008	Diode Low Leakage	Fairchild	IN458A	7
CR12 - CR19	200 001	Diode Si G.P.	Fairchild/Mullard	IN4148	-
CR20 - CR21	200 008	Diode Low Leakage	Fairchild	IN458A	-
CR22 - CR23	200 001	Diode Si G.P.	Fairchild/Mullard	IN4148	-
CR101-CR150	200 001	Diode Si G.P.	Fairchild/Mullard	IN4148	-
ZD1 - ZD2	210 056	Zener Diode. 5V6 400mW	Mullard	BZY88-C5V6	2
ZD3 - ZD4	210 150	Zener Diode. 15V 250mW	Mullard	BZX83-C15	2
ZD5 - ZD6	210 100	Zener Diode. 10V 250mW	Mullard	BZX83-C10	2
ZD7 - ZD8	210 240	Zener Diode. 24V 250mW	Mullard	BZX83-C24	2

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	PART No.		MANUFACTURER	PART No.	Per Assy.
Q1 - Q27	240 001	Transistor N.P.N. G.P.	Fairchild/Waycom	BC184K	36
Q28 - Q30	250 001	Transistor P.N.P. G.P.	Fairchild/Waycom	BC214K	7
Q31	240 001	Transistor N.P.N. G.P.	Fairchild/Waycom	BC184K	-
Q32	250 001	Transistor P.N.P. G.P.	Fairchild/Waycom	BC214K	-
Q33 - Q37	240 001	Transistor N.P.N. G.P.	Fairchild/Waycom	BC184K	-
Q38	250 001	Transistor P.N.P. G.P.	Fairchild/Waycom	BC214K	-
Q39	240 001	Transistor N.P.N. G.P.	Fairchild/Waycom	BC184K	-
Q40					
Q41 - Q43	230 003	N-Fet Switch G.P.	Teledyne/National	U1899E/NF510	7
Q44	230 016	N-Fet Switch Low Leakage	Teledyne/	2N3824 Black	1
Q45	230 002	N-Fet Switch G.P.	Teledyne/National	U1994E/NF500	3
Q46 - Q47	230 012	N-Fet Switch Low Leakage	Teledyne	2N3824	2
Q48	230 003	N-Fet Switch G.P.	Teledyne/National	U1899E/NF510	-
Q49 - Q50	230 002	N-Fet Switch G.P.	Teledyne/National	U1994E/NF500	-
Q51	250 006	Transistor P.N.P. G.P.	Fairchild	BC322	1
Q52	240 001	Transistor N.P.N. G.P.	Fairchild	BC184K	-
Q53	250 001	Transistor P.N.P. G.P.	Fairchild	BC214K	-
Q54	240 001	Transistor N.P.N. G.P.	Fairchild	BC184K	-
Q55	250 001	Transistor P.N.P. G.P.	Fairchild	BC214K	-
Q56 - Q58	230 003	N-Fet Switch G.P.	Teledyne/National	U1899E/NF510	-

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	PART No.		MANUFACTURER	PART No.	Per Assy.
M1	270 021	Quad 2 Input Multiplexer	Texas/National	74L157N	2
M2	270 022	4 Bit Up/Down Decade Counter	Texas/National	74L192N	1
M3 - M4	270 017	Quad 2 Input Nand	Texas/National	74L00N	2
M5	270 018	Hex Invertor	Texas/National	74L04N	1
M6	270 020	BCD to Decimal Decoder	Texas/National	74L42N	1
M7	270 019	Triple 3 Input Nand	Texas/National	74L10N	1
M8	270 021	Quad 2 Input Multiplexer	Texas/National	74L157N	-
M9 - M14	220 005	Opto Isolator	Fairchild	FCD820	6
M21	290 013	Linear IC LM312H Op. Amp	National	LM312H(White)	1
M22	290 009	Linear IC LM301AH Op. Amp	National	LM301AH(Black)	1
M23	* 290 014	Linear IC LM312H Op. Amp	National	LM312H(Orange)	* 1
M24 - M26	** 290 012	Linear IC 741 Op. Amp	Fairchild	741HC(Red)	** 3
RL1	330 003	Relay 28V D.P.D.T.	Potter & Brumfield	R10-E1-L2-S3-2K	1
S1 - S7	700 011	Switch 7 x 2 Pole Interlock	Lipa & Isostat		1
S8 - S10	700 013	Switch 3 x 2 Pole Push On/			
		Off	Lipa & Isostat		1
S11-S13	700 012	Switch 3 x 2 Pole Interlock	Lipa & Isostat		1
	700 020	Button. Chrome	Lipa & Isostat		13

NOTES.

* May use 290 013

** May use 290 011 or 260 002

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	PART No.		MANUFACTURER	PART No.	Per Assy.
	410 003 - 3	P.C.B.			1
J1 - J2	605 005	Connector 13 Way	Amp	1-163680-2	2
J3 - J4	605 002	Socket D.I.L. 16 Pin	Antiference	ICN-163-S3	2
	601 002	Connector Snap	Amp	60803-1	7
	602 001	Terminal F.S.V.	Molex	02-04-1875	8
	602 005	Connector 8 Way	Molex	2460-8	8
	602 006	Connector 7 Way	Molex	2460-7	8
	602 004	Socket D.I.L. Breakaway	Molex	1938-4	120
	620 001	P.T.F.E. Cloverleaf	Sealectro	FT-E-12	1
	620 002	P.T.F.E. Standoff	Sealectro	STSM1P47	5
	620 003	Terminal Rivet	Harwin	H2105A	10
	611 004	Screw St. Zinc Pass		M3 x 6mm	1
	612 005	Standoff M3 x 23mm	Harwin		5
	615 002	Nut M3 Hex		M3	1
	450 004	Environmental Shield	Timpak		1
	459 112	Relay Bracket	K.D.P		1
	540 001	B.T.C. Wire 24 SWG			
	590 004	Sleeving			

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	PART No.		MANUFACTURER	PART No.	Per Assy.
R1 - R28		Not Used			-
R29-R31	000 273	27K 5% ¼W Carbon	Mullard	CR25	4
R32	000 104	100K 5% ¼W Carbon	Mullard	CR25	6
R33	000 103	10K 5% ¼W Carbon	Mullard	CR25	17
R34	000 47L	470R 5% ¼W Carbon	Mullard	CR25	2
R35	000 103	10K 5% ¼W Carbon	Mullard	CR25	-
R36	000 471	470R 5% ¼W Carbon	Mullard	CR25	-
R37	063 102	1K ⅜" Cermet Pot	Beckman	72P	2
R38	019 101	9K1 1% ½W Metal Film	Welwyn	4033C	2
R39	019 101	9K1 1% ½W Metal Film	Welwyn	4033C	-
R40	000 102	1K 5% ¼W Carbon	Mullard	CR25	3
R41	000 103	10K 5% ¼W Carbon	Mullard	CR25	-
R42	000 103	10K 5% ¼W Carbon	Mullard	CR25	-
R43	000 222	2K2 5% ¼W Carbon	Mullard	CR25	7
R44	000 102	1K 5% ¼W Carbon	Mullard	CR25	-
R45	000 103	10K 5% ¼W Carbon	Mullard	CR25	-
R46	000 103	10K 5% ¼W Carbon	Mullard	CR25	-
R47	000 103	10K 5% ¼W Carbon	Mullard	CR25	-
R48	000 331	330R 5% ¼W Carbon	Mullard	CR25	6
R49	000 103	10K 5% ¼W Carbon	Mullard	CR25	-
R50	000 393	39K 5% ¼W Carbon	Mullard	CR25	1
R51	000 331	330R 5% ¼W Carbon	Mullard	CR25	-
R52	000 332	3K3 5% ¼W Carbon	Mullard	CR25	3

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	PART No.		MANUFACTURER	PART No.	Per Assy.
R53	000 103	10K 5% ¼W Carbon	Mullard	CR25	-
R54	000 103	10K 5% ¼W Carbon	Mullard	CR25	-
R55	000 103	10K 5% ¼W Carbon	Mullard	CR25	-
R56	000 103	10K 5% ¼W Carbon	Mullard	CR25	-
R57	000 223	22K 5% ¼W Carbon	Mullard	CR25	8
R58	000 223	22K 5% ¼W Carbon	Mullard	CR25	-
R59	000 223	22K 5% ¼W Carbon	Mullard	CR25	-
R60	000 331	330R 5% ¼W Carbon	Mullard	CR25	-
R61	000 331	330R 5% ¼W Carbon	Mullard	CR25	-
R62	000 222	2K2 5% ¼W Carbon	Mullard	CR25	-
R63	000 222	2K2 5% ¼W Carbon	Mullard	CR25	-
R64	000 561	560R 5% ¼W Carbon	Mullard	CR25	1
R65	000 331	330R 5% ¼W Carbon	Mullard	CR25	-
R66	000 331	330R 5% ¼W Carbon	Mullard	CR25	-
R67	000 223	22K 5% ¼W Carbon	Mullard	CR25	-
R68	000 331	330R 5% ¼W Carbon	Mullard	CR25	-
R69-R70	440 020	FSV (22K 5% Carbon)	Mullard	CR25	1 of Kit
R71	000 223	22K 5% ¼W Carbon	Mullard	CR25	-
R72	000 321	320R 5% ¼W Carbon	Mullard	CR25	1
R73	070 017	1KO .1% ¼W WW	Mann	M250	1
R74	000 272	2K7 5% ¼W Carbon	Mullard	CR25	2
R75	063 104	100K ⅜" Cermet Pot	Beckman	72P	1
R76	070 016	4KO .1% ¼W WW	Mann	M250	1

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	PART No.		MANUFACTURER	PART No.	Per Assy.
R77 - R79	000 563	56K 5% ¼W Carbon	Mullard	CR25	4
R80	000 563	56K 5% ¼W Carbon	Mullard	CR25	-
R81	000 332	3K3 5% ¼W Carbon	Mullard	CR25	-
R82	000 222	2K2 5% ¼W Carbon	Mullard	CR25	-
R83	000 562	5K6 5% ¼W Carbon	Mullard	CR25	3
R84	000 222	2K2 5% ¼W Carbon	Mullard	CR25	-
R85	070 021	13KO 1% ¼W WW	Mann	M250	1
R86	063 500	50R ⅜" Cermet Pot	Beckman	72P	2
R87	440 021	FSV 220K 1% ¼W MF	Welwyn	4033C	2 of Kit
R88	011 201	1K2 1% ¼W MF	Welwyn	4033C	1
R89	070 015	10KO .1% ¼W WW	Mann	M250	3
R90	000 562	5K6 5% ¼W Carbon	Mullard	CR25	-
R91	000 272	2K7 5% ¼W Carbon	Mullard	CR25	-
R92	000 103	10K 5% ¼W Carbon	Mullard	CR25	-
R93	000 475	4M7 10% ¼W Carbon	Mullard	CR25	1
R94	070 015	10KO .1% ¼W WW	Mann	M250	-
R95	063 500	50R ⅜" Cermet Pot	Beckman	72P	-
R96	070 015	10KO .1% ¼W WW	Mann	M250	-
R97	000 472	4K7 5% ¼W Carbon	Mullard	CR25	4
R98		Ext. Ref Option Only			
R99	000 103	10K 5% ¼W Carbon	Mullard	CR25	-
R100	000 223	22K 5% ¼W Carbon	Mullard	CR25	-
R101	014 702	47K 1% ¼W MF	Welwyn	4033C	1

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	PART No.		MANUFACTURER	PART No.	Per Assy.
R102	000 684	680K 5% ¼W Carbon	Mullard	CR25	1
R103	000 473	47K 5% ¼W Carbon	Mullard	CR25	1
R104-R105	440 019	FSV (1M 5% ¼W Carbon)	Mullard	CR25	1 of Kit
R106	063 102	1K ⅜" Cermet Pot	Beckmann	72P	-
R107	000 472	4K7 5% ¼W Carbon	Mullard	CR25	-
R108	000 562	5K6 5% ¼W Carbon	Mullard	CR25	-
R109	000 107	100M 20% ¼W Carbon	AB	CB10	1
R110	000 222	2K2 5% ¼W Carbon	Mullard	CR25	-
R111	000 683	68K 5% ¼W Carbon	Mullard	CR25	1
R112		FSV (6K8 5% Carbon)	Mullard	CR25	-
R113	000 332	3K3 5% ¼W Carbon	Mullard	CR25	-
R114	000 102	1K 5% ¼W Carbon	Mullard	CR25	-
R115	000 470	47R 5% ¼W Carbon	Mullard	CR25	1
R116	000 152	1K5 5% ¼W Carbon	Mullard	CR25	2
R117	000 103	10K 5% ¼W Carbon	Mullard	CR25	-
R118	000 273	27K 5% ¼W Carbon	Mullard	CR25	-
R119	000 101	100R 5% ¼W Carbon	Mullard	CR25	1
R120	000 472	4K7 5% ¼W Carbon	Mullard	CR25	-
R121-R122	000 104	100K 5% ¼W Carbon	Mullard	CR25	-
R123	000 222	2K2 5% ¼W Carbon	Mullard	CR25	-
R124	000 472	4K7 5% ¼W Carbon	Mullard	CR25	-
R125	000 103	10K 5% ¼W Carbon	Mullard	CR25	-
R126-R128	000 104	100K 5% ¼W Carbon	Mullard	CR25	-

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	PART No.		MANUFACTURER	PART No.	Per Assy.
R129	000 152	1K5 5% ¼W Carbon	Mullard	CR25	-
R130	000 103	10K 5% ¼W Carbon	Mullard	CR25	-
R131-R132	000 223	22K 5% ¼W Carbon	Mullard	CR25	-
C1	180 004	4700mF F/16V Al. Elect	Wima	Printilyt 4700/16 New	1
C2	110 013	.1mF 250V Py.	Mullard	C280AE P100K	1
C3	150 003	47mF/63V Dipped Tant	Union Carbide	K47E6	1
C4 - C5	102 102	1KpF 500V Cer. Disc	Erie	831	6
C6 - C7	101 103	.01mF 250V Cer. Disc	Erie	801	8
C8 - C11	101 103	.01mF 250V Cer. Disc	Erie	831	-
C12	150 005	2.2mF 16V Dipped Tant	Union Carbide	K2R2E16	2
C13-C14	150 001	22mF/16V Dipped Tant	Union Carbide	K22E16	4
C15	102 221	220pF Cer. Disc	Erie	801	2
C16	104 012	4700pF Cer Disc K170051	Erie	811/K170051	1
C17	102 47L	470pF 500V Cer. Disc	Erie	801	1
C18	102 221	220pf 500V Cer. Disc	Erie	801	-
C19	102 102	1KpF 500V Cer. Disc	Erie	831	-
C20	150 005	2.2mF/=6V Tant Bead	Union Carbide	K2R2E16	-
C21	150 007	6.8mF/16V Tant Bead	Union Carbide	K6R8E16	1
C22	110 004	.047mF 250V Py	Mullard	C280AE P47K	-
C23	180 005	1000mF/25V Al, Elect	Wima	Printilyt	2
C24	180 005	1000mF/25V Al. Elect	Wima	Printilyt	-

NOTES.

DATE.	datron ELECTRONICS LTD.
DRAWN BY.	
CHECK	TITLE 1041 A-D PCB
NEXT DRAWING	
REV 2	DRAWING NUMBER 409120A SHEET 6 OF 12

	PART No.		MANUFACTURER	PART No.	Per Assy.
C25	150 001	22mF/16V Dipped Tant	Union Carbide	K22E16	-
C26	150 001	22mF/16V Dipped Tant	Union Carbide	K22E16	-
C27-C28	102 470	47pF Cer. Disc	Erie	831 or 801	2
C29	102 102	1KpF Cer. Disc	Erie	831	-
C30-C31	102 101	100pF 500V Cer. Disc	Erie	831	3
C32-C33	102 102	1KpF Cer. Disc	Erie	831	-
C34	110 011	.47mF/100V Py	Wima	MKS 100V	1
C35	140 002	.47mF/400V d.c. 10% Polypro	Wima	MKP 10	1
C36	102 101	100pF Cer. Disc	Erie	801 or 831	-
C37	101 103	.01mF 250V Cer. Disc	Erie	801	-
C38	Not Used				
C39	Not Used				
C40	Not Used				
C41	150 010	.33mF/35V Dipped Tant	Erie	801	1
C42	Not Used				
C43	101 103	.01mF Cer. Disc	Erie	801	-
C44	Not Used				
C45-C46	110 012	150pF 10% 400V+300ppm Py	Wima	Tropyfol F	2

NOTES.

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CHECK	
NEXT DRAWING	DRAWING NUMBER 409120A SHEET 7 OF 12
Rev 2	

	PART No.		MANUFACTURER	PART No.	Per Assy.
CR1 - CR3	200 001	Sil Gen Purpose		IN4148	18
CR4 - CR6	200 005	Germ Gen Purpose	Emihus	HG5009	3
CR7	200 001	Sil Gen Purpose		IN4148	-
CR8	210 100	10V 400mW Zener		BZY88 C10V	1
CR9 - CR10	200 001	Sil Gen Purpose		IN4148	-
CR11	Not Used				
CR12	214 002	TC Reference Zener 6.2V	Centralab (Lucas)	IN827A	1
CR13 - CR24	200 001	Sil Gen Purpose		IN4148	-
W1	209 003	1.5 Amp 100V Rect. Bridge	G.I.	WS01	1
W2	209 004	1.0 Amp 100V Rect. Bridge	G.I.	W01	2
W3	209 004	1.0 Amp 100V Rect. Bridge	G.I.	W01	-

NOTES.

DATE.	datron ELECTRONICS LTD.
DRAWN BY.	TITLE 1041 A-D PCB
CHECK JKP	
NEXT DRAWING	
Rev 2	DRAWING NUMBER 409120A SHEET 8 OF 12

	PART No.		MANUFACTURER	PART No.	Per Assy.
Q1	240 006	Sil N.P.N. HF GP	Fairchild	2N 3904	5
Q2	240 006	Sil N.P.N. HF GP	Fairchild	2N 3904	-
Q3 - Q5 - Q6	239 011	Matched set of 3 Fets	Datron Sel. Teledyne	3 x U1994E ΔRon <30 Ω	1 Set
Q4	230 002	Fet N Junct GP	Teledyne	U1994E	1
Q7	240 006	Sil N.P.N. HF GP		2N3904	-
Q8	240 006	Sil N.P.N. HF GP		2N3904	-
Q9	250 004	Sil P.N.P. HF GP		2N3906	3
Q10	240 001	Sil N.P.N. HiB GP		BC184K	4
Q11	240 001	Sil N.P.N. HiB GP		BC184K	-
Q12	240 001	Sil N.P.N. HiB GP		BC184K	-
Q13	240 001	Sil N.P.N. HiB GP		BC184K	-
Q14	250 004	Sil P.N.P. HF GP		2N3906	-
Q15	250 004	Sil P.N.P. HF GP		2N3906	-
Q16	240 007	Sil N.P.N. HF Switch		2N3646	2
Q17	240 007	Sil N.P.N. HF Switch		2N3646	-
Q18	240 009	Sil N.P.N. 80V Driver	Motorola	MPSL01	3
Q19	240 009	Sil N.P.N. 80V Driver		MPSL01	-
Q20	240 009	Sil N.P.N. 80V Driver		MPSL01	-
Q21	240 006	Sil N.P.N. HG GP	Fairchild	2N3904	-

NOTES.

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DRAWN BY.	TITLE 1041 A-D PCB
CHECK JRP	
NEXT DRAWING	
REV 2	DRAWING NUMBER 409120A SHEET 9 OF ~~12~~

	PART No.		MANUFACTURER	PART No.	Per Assy.
M1	270 001	Dig IC Quad Nand		7400N Commerical	7
M2	Not Used				
M3	270 024	Dig IC 7Seg Decode	Sperry	DD700, DM8880	4
M4-M6	270 024	Dig IC 7Seg Decode		DD700	-
M7-M8	270 001	Dig IC Quad Nand		7400N Commercial	-
M9	270 006	Dig IC Hex Inv		7405N Commercial	1
M10-M13	270 026	Dig IC Quad Latch		74L75N Commercial	4
M14	270 018	Dig IC Hex Inv		74L04N Commercial	1
M15	270 027	Dig IC Dual D FF		74L74N Commercial	4
M16	270 008	Dig IC Triple Nand		7410N Commercial	2
M17-M20	270 025	Dig IC Decade Count		74L90N Commercial	4
M21-M22	270 027	Dig IC Dual D FF		74L74N Commercial	-
M23	270 001	Dig IC Quad Nand		7400N Commercial	-
M24	290 003	Timer Monostable	Signetics	NE555V Commercial	1
M25	270 002	Dig IC Quad Nand		7401N Commercial	1
M26	270 001	Dig IC Quad Nand		7400N Commercial	-
M27	270 008	Dig IC Triple Nand		7410N Commercial	-
M28	270 001	Dig IC Quad Nand		7400N Commercial	-
M29	270 023	Dig IC Quad Nand Buffer		7437N Commercial	1
M30	270 001	Dig IC Quad Nand		7400N Commercial	-
M31	270 027	Dig IC Dual D FF		74L74N Commercial	-
M32	260 009	Linear IC LM318	National	LM318H	1
M33	* 290 010	Linear IC LM301A Op Amp	National	LM301AH Sel.red	* 1

NOTES.

* May use 290 009 or 260 001

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DRAWN BY.	TITLE 1041 A-D PCB
CHECK IRP	
NEXT DRAWING Rev 2	DRAWING NUMBER 409120A SHEET 10 OF ~~12~~

	PART No.		MANUFACTURER	PART No.	Per Assy.
M34	290 011	Linear IC 741 Op Amp	Fairchild/Datron	Sel. Voff <1.5mV	1
M35	260 002	Linear IC 741 Op Amp	Fairchild	741HC	2
M36	260 002	Linear IC 741 Op Amp		741HC	-
M37	260 005	Linear IC Power Regulator			
		5V	Motorola	MC7805	1
M38	260 006	Linear IC Power Regulator			
		15V	Motorola	MC7815	2
M39	260 006	Linear IC Power Regulator			
		15V	Motorola	MC7915	-

NOTES.

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DRAWN BY.	TITLE 1041 A-D PCB
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NEXT DRAWING	
REV 2	DRAWING NUMBER 409120A SHEET 11 OF ~~12~~

	PART No.		MANUFACTURER	PART No.	Per Assy.
T1	300 002	Toroidal Mains Tx	Plessey Windings		1
T3 - T4	310 001	Pulse Tx (Logic)	Newport Inst.	76616/4	2
J3	605 002	16 way D.I.L. Socket	Antiference	ICN-163-53	1
	620 003	PCB Solder Terminal	Harwin	H2105A	14
	602 001	FSV Terminal	Molex	0204 1875	10
	601 002	Connector Terminal	Amp	60803-1	12
	459 138	Transistor Heat Dissipator	KDP ES	459138	2
	459 139	Heat Dissipator	KDP ES	459139	1
	419 108A	P.C.B.		419108A ISS 2	1
	618 001	Transistor Mounting Kit			3
	611 006	M3 x 10mm Pozipan	GKN		2
	611 007	M3 x 6mm Pozipan	GKN		2
	615 002	M3 Nut	GKN		2
	602 004	D.I.L. Socket Strip Terms	Molex	1938-4	430
	602 005	8 way D.I.L. Skt Str.Bucket	Molex	2460-8	16
	602 006	7 way D.I.L. Skt Str Bucket	Molex	2460-7	42
	605 003	40 way DS .1" PCB Cnctr	Pye	MLD 205N0101 ML	1
S1	700 005	Switch PCB Push On Push Off	Lipa & Isostat	CD 15 2 Pole	2
S2	700 004	Switch PCB Momentary	Lipa & Isostat	CD 15 2 Pole	1
S3	700 005	Switch PCB Push On Push Off	Lipa & Isostat	CD 15 2 Pole	-

NOTES.

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DRAWN BY.	TITLE 1041 A-D PCB
CHECK IRP	
NEXT DRAWING	DRAWING NUMBER 409120A
REV 2	SHEET 12 OF ~~12~~

	PART No.		MANUFACTURER	PART No.	Per Assy.
R1	000 102	1K 5% ¼W Carbon	Mullard	CR25	3
R2	000 221	220R 5% ¼W Carbon	Mullard	CR25	1
R3	000 562	5K6 5% ¼W Carbon	Mullard	CR25	8
R4	000 562	5K6 5% ¼W Carbon	Mullard	CR25	-
R5	000 681	680R 5% ¼W Carbon	Mullard	CR25	1
R6 - R10	000 562	5K6 5% ¼W Carbon	Mullard	CR25	-
R11	Not Used				
R12	Not Used				
R13	000 102	1K 5% ¼W Carbon	Mullard	CR25	-
R14	000 102	1K 5% ¼W Carbon	Mullard	CR25	-
R15	000 682	6K8 5% ¼W Carbon	Mullard	CR25	1
R16 - R18	000 153	15K 5% ¼W Carbon	Mullard	CR25	3
R19	000 224	220K 5% ¼W Carbon	Mullard	CR25	1
R20	000 562	5K6 5% ¼W Carbon	Mullard	CR25	-
R21	000 273	27K 5% ¼W Carbon	Mullard	CR25	1
C1	150 003	47mF 6.3V Tant Bead	Union Carbide	K47E6	1
C2	110 013	.1mF 250V PY	Mullard	C280 AE P100K	1
C3 - C4	110 015	.015mF 100V PY	Wima	FKS 2	2
L1	370 001	10mH RF Choke	Plessey	58/10/0011/10	1
CR1 - CR2	200 001	Diode Sil Gen Purpose		IN4148	2
CR3	200 002	Sil Rect Diode 100V	G.I.	IN4001	1
W1	209 007	Bridge Rectifier 400V		W04	1

NOTES.

DATE. 25/11/73	datron ELECTRONICS LTD.
DRAWN BY.	TITLE SPERRY .5" DISPLAY PCB ASSY
CHECK	
NEXT DRAWING	DRAWING NUMBER 400 026 SHEET 2 OF 3

			MANUFACTURER	PART No.	Per Assy.
Q1 - Q2	240 001	Sil N.P.N. Hi B GP		BC184K	2
Q3	240 011	Sil N.P.N. Med Power		BC338	1
Q5 - Q8	240 009	Sil N.P.N. Hi Volt GP	Motorola	MPSL01	4
M1	270 023	Quad Nand Buffer	National	7437N	1
FL1 - FL4	920 005	Filament Lamp 5V 60mA	G.I.	V683	4
DM1	800 002	Disp Module ± 1 .5"	Sperry	SP351	1
DM2	800 003	Disp Module 888 .5"	Sperry	SP353	1
T1	300 004	Toroidal Tx 5V-180V			1
	604 003	Connector Strip Pins 11 Way	Amp	163740-9	4
	602 004	D.I.L. Socket Strip	Molex	1938-4	14
	602 006	D.I.L. Skt Strip 7 Way Carrier	Molex	2460-7	2
	410 010	THP PCB		410 010-2	1
	611 004	Screw M3 x 6 Pozipan			1
	450 003	Function Block Inj. Mould	Norwich Plastics		1
	420 013	F.mV. Disp Negative			1

NOTES.

DATE. 25/11/73	datron ELECTRONICS LTD.
DRAWN BY.	TITLE SPERRY .5" DISPLAY PCB ASSY
CHECK	
NEXT DRAWING	
	DRAWING NUMBER 400 026
	SHEET 3 OF 3

	PART No.		MANUFACTURER	PART No.	Per Assy.
R1 - R5	070 015	10K 0.1% ¼W WW	Mann	M250	5
R6 - R7	070 017	1K 0.1% ¼W WW	Mann	M250	2
R8	070 018	4.53K 0.1% ¼W WW	Mann	M250	1
R9	070 022	44.9K 0.1% ¼W WW	Mann	M250	1
R10	070 023	449K 0.1% ¾W WW	Mann	M750	1
R11	015 603	560K 1% ¼W MF	Welwyn	4033C	1
R12 - R13	011 002	10K 1% ¼W MF	Welwyn	4033C	2
R14	090 003	Matched Pair MF	Erg		1 Set
R15		2K2/2M2 .02%			
R16 - R17	440 026	FSV (150K - 3M3)			1 of Kit
R18 - R19	440 027	FSV (560K - 4M7)			1 of Kit
R20	014 708	47R 1% ¼W MF	Welwyn	4033C	1
R21	000 224	220K 5% ¼W Carbon	Mullard	CR25	1
R22	004 681	680R 5% 1W Met-Ox	Electrosil	TR5	1
R23	000 824	820K 5% ¼W Carbon	Mullard	CR25	1
R24	000 476	47M 10% ¼W Carbon	Allen Bradley	CB10	1
R25	000 473	47K 5% ¼W Carbon	Mullard	CR25	3
R26 - R32	000 104	100K 5% ¼W Carbon	Mullard	CR25	7
R33 - R39	000 106	10M 10% ¼W Carbon	Mullard	CR25	8
R40 - R41	000 473	47K 5% ¼W Carbon	Mullard	CR25	-
R43	000 106	10M 10% ¼W Carbon	Mullard	CR25	-
R43	Not Used				
R44	000 474	470K 5% ¼W Carbon	Mullard	CR25	1

NOTES.

DATE. 18/09/74	datron ELECTRONICS LTD.
DRAWN BY.	TITLE 1041 RESISTANCE CONVERTOR (02)
CHECK	
NEXT DRAWING	
Rev. A	DRAWING NUMBER 400 036 SHEET 2 OF 4

	PART No.		MANUFACTURER	PART No.	Per Assy.
R45	000 103	10K 5% ¼W Carbon	Mullard	CR25	1
R46	000 225	2M2 10% ¼W Carbon	Mullard	CR25	1
R47 - R48	090 001	PTC Thermistor	Mullard	VA 8650	2
R49 - R50	063 500	50R ⅜" Cermet Pot	Beckman	72P	2
R51	063 100	10R ⅜" Cermet Pot	Beckman	72P	1
R52	063 504	500K ⅜" Cermet Pot	Beckman	72P	1
R53	063 201	200R ⅜" Cermet Pot	Beckman	72P	1
R54	063 202	2K ⅜" Cermet Pot	Beckman	72P	1
R55	063 205	2M ⅜" Cermet Pot	Beckman	72P	1
R56	000 105	1M 5% ¼W Carbon	Mullard	CR25	1
R57 - R58	000 222	2K2 5% ¼W Carbon	Mullard	CR25	2
R59	063 204	200K ⅜" Cermet Pot	Beckman	72P	1
C1	101 102	1KpF 500V Cer Disc	Erie	831	2
C2 - C3	101 471	470pF 500V Cer Disc	Erie	831	2
C4	101 102	1KpF 500V Cer Disc	Erie	831	-
CR1 - CR7	200 008	Low Leakage Diode	Fairchild	IN458A	7
CR8 - CR28	200 001	GP Sil. Diode	Fairchild	IN4148	21
CR29 - CR30	Not Used				
CR31 - CR34	200 006	Sil Rect Hi Volt		IN4005	4
CR35	210 091	9.1 V 400mW Zener		BZY88C9V1	1
CR36 - CR37	213 001	10V 5 W Zener		IN5347	2

NOTES.

DATE. 18/09/74	datron ELECTRONICS LTD.
DRAWN BY.	TITLE 1041 RESISTANCE CONVERTOR (02)
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NEXT DRAWING	
Rev A	DRAWING NUMBER 400 036 SHEET 3 OF 4

	PART No.		MANUFACTURER	PART No.	Per Assy.
Q1	250 001	Transistor Sil P.N.P. GP	Waycom	BC214K	1
Q2	230 003	N Fet Sil GP Switch	Teledyne	U1899E	1
Q3 - Q4	230 002	N Fet Sil GP	Teledyne	U1994E	6
Q9	240 012	Transistor Sil N.P.N. 1 Watt	Motorola	2N3053	1
Q10	250 006	Transistor Sil P.N.P. GP	Fairchild	BC322	1
M1	260 002	Linear IC 741	Fairchild	741 HC	1
M2	(1) 290 004	Linear IC LM312 Sel	National	LM312H Sel Red Spot	1
M3	(2) 290 014	Linear IC LM312 Sel	National	LM312H Sel Orange Spot	1
RL1	330 001	Relay BiF 4P2W 28V	Potter & Brumfield	R10-E1-Z4-Q3.2K	1
	459 112	Relay Bracket	KDP ES	459 112	1
J1	604 004	13 Way Amp Male CNCTR	Amp	1-163749-2	1 Set
	410 007-2	PCB			
	602 001	FSV Terminal	Molex	02-04-1875	8
		23mm x M3 Rivet SNDF	Harwin	CS	3
		Rivet Solder Terminal	Harwin		
		P - Clip	Plex		2
		M3 x 6 Pozipan	GKN		3
		M3 Nut	GKN		3
		M3 Shakeproof Washer	GKN		3

NOTES.

(1) May be Rawstock No. 260 008

(2) May be selected No. 290 013

DATE. 18/09/74	datron ELECTRONICS LTD.
DRAWN BY.	TITLE 1041 RESISTANCE CONVERTOR (02)
CHECK	
NEXT DRAWING	
Rev A	DRAWING NUMBER 400 036
	SHEET 4 OF 4

	PART No.		MANUFACTURER	PART No.	Per Assy.
R1 - R2	000 222	2K2 5% ¼W Carbon	Mullard	CR25	4
R3 - R6	050 005	275K .25% ⅛W MF	Erg	EE 0.25 - C-C4	4
R7	000 332	3K3 5% ¼W Carbon	Mullard	CR25	3
R8	050 004	995K .25% ¼W MF	Erg	EE 0.25 - C-C4	3
R9	063 103	10K ⅜" Cer Pot	Beckman	72P	3
R10	050 006	10K1 .25% ⅛W MF	Erg	EE 0.125 - C-C4	2
R11	000 330	33R 5% ¼W Carbon	Mullard	CR25	1
R12	000 332	3K3 5% ¼W Carbon	Mullard	CR25	-
R13	000 825	8M2 10% ¼W Carbon	Mullard	CR25	1
R14	000 105	1M 5% ¼W Carbon	Mullard	CR25	8
R15	050 004	995K .25% ¼W MF	Erg	EE 0.25 - C-C4	-
R16	063 103	10K ⅜" Cer Pot	Beckman	72P	-
R17	050 007	110.5K .25% ⅛W MF	Erg	EE 0.125 - C-C4	1
R18	063 102	1K ⅜" Cer Pot	Beckman	72P	2
R19	000 473	47K 5% ¼W Carbon	Mullard	CR25	3
R20	000 332	3K3 5% ¼W Carbon	Mullard	CR25	-
R21	050 004	995K .25% ¼W MF	Erg	EE 0.25 - C-C4	-
R22	063 103	10K ⅜" Cer Pot	Beckman	72P	-
R23	000 473	47K 5% ¼W Carbon	Mullard	CR25	-
R24	000 271	270R 5% ¼W Carbon	Mullard	CR25	1
R25	050 014	99K5 .25% ⅛W MF	Erg	EE 0.125 - C-C4	1
R26	063 102	1K ⅜" Cermet Pot	Beckman	72P	-
R27	000 105	1M 5% ¼W Carbon	Mullard	CR25	-

NOTES.

DATE. 15/08/74	datron ELECTRONICS LTD.
DRAWN BY.	TITLE 1041 AC CONVERTOR
CHECK	
NEXT DRAWING	
Rev 2	DRAWING NUMBER 400 037
	SHEET 2 OF ~~12~~

	PART No.		MANUFACTURER	PART No.	Per Assy.
R28	050 006	10K1 .25% ⅛W MF	Erg	EE .125 - C-C4	-
R29	000 105	1M 5% ¼W Carbon	Mullard	CR25	-
R30	000 104	100K 5% ¼W Carbon	Mullard	CR25	8
R31	000 103	10K 5% ¼W Carbon	Mullard	CR25	8
R32	000 101	100R 5% ¼W Carbon	Mullard	CR25	6
R33	000 820	82R 5% ¼W Carbon	Mullard	CR25	1
R34		FSV (68K - 1M)	Welwyn/Mullard	4033C up to 330K	1 of Pair
R35		FSV (68K - 1M)	Welwyn/Mullard	CR25 over 330K	
R36	063 200	20R ⅜" Cer Pot	Beckman	72P	1
R37	070 024	2K2 1% Wirewound	Mann	M250	2
R38	070 024	2K2 1% Wirewound	Mann	M250	-
R39	000 824	820K 5% ¼W Carbon	Mullard	CR25	1
R40	000 102	1K 5% ¼W Carbon	Mullard	CR25	7
R41		FSV (470K - 4M7)	Mullard	CR25	1 of Pair
R42		FSV (470K - 4M7)	Mullard	CR25	
R43	000 102	1K0 5% ¼W Carbon	Mullard	CR25	-
R44	000 683	68K 5% ¼W Carbon	Mullard	CR25	3
R45	000 154	150K 5% ¼W Carbon	Mullard	CR25	2
R46	000 154	150K 5% ¼W Carbon	Mullard	CR25	-
R47	000 682	6K8 5% ¼W Carbon	Mullard	CR25	4
R48	000 101	100K 5% ¼W Carbon	Mullard	CR25	-
R49	000 102	1K0 5% ¼W Carbon	Mullard	CR25	-
R50	000 470	47R 5% ¼W Carbon	Mullard	CR25	1

NOTES.

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DRAWN BY.	TITLE 1041 AC CONVERTOR
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NEXT DRAWING Rev 2	DRAWING NUMBER 400 037
	SHEET 3 OF 12

	PART No.		MANUFACTURER	PART No.	Per Assy.
R51		FSV (220K - 2M2)	Mullard	CR25	1 of Pair
R52		FSV (220K - 2M2)	Mullard	CR25	
R53	000 102	1K 5% ¼W Carbon	Mullard	CR25	-
R54	000 102	1K 5% ¼W Carbon	Mullard	CR25	-
R55	000 103	10K 5% ¼W Carbon	Mullard	CR25	-
R56	000 104	100K 5% ¼W Carbon	Mullard	CR25	-
R57					
R58	050 011	3K3 .25% ⅛W MF	Erg	Ee 0.125 - C-C4	2
R59	050 011	3K3 .25% ⅛W MF	Erg	EE 0.125 - C-C4	-
R60	050 010	8K95 .25% ⅛W MF	Erg	EE 0.125 - C-C4	1
R61	063 101	100R ⅜" Cer Pot	Beckman	72P	2
R62	050 009	18K .25% ⅛W MF	Erg	EE 0.125 - C-C4	1
R63	050 013	20K .25% ⅛W MF	Erg	EE 0.125 - C-C4	1
R64	000 222	2K2 5% ¼W Carbon	Mullard	CR25	-
R65	050 012	21K .25% ⅛W MF	Erg	EE 0.125 - C-C4	1
R66		FSV (150K - 470K)	Welwyn	4033C	1 of Kit
R67	063 101	100R ⅜" Cer Pot	Beckman	72P	-
R68	000 183	18K 5% ¼W Carbon	Mullard	CR25	2
R69	290 002	Part of RMS Kit	Datron	290 002	-
R70	063 050	50R ⅜" Cer Pot	Beckman	72P	1
R71	000 390	39R 5% ¼W Carbon	Mullard	CR25	1
R72	290 002	Part of RMS Kit	Datron	290 002	-
R73	000 108	1R0 5% ¼W Carbon	Mullard	CR25	1

NOTES.

DATE. 15/08/74	datron ELECTRONICS LTD.
DRAWN BY.	TITLE 1041 AC CONVERTOR
CHECK	
NEXT DRAWING Rev 2	DRAWING NUMBER 400 037
	SHEET 4 OF 12

	PART No.		MANUFACTURER		
R74	000 912	9K1 5% ¼W Carbon	Mullard	CR25	1
R75	000 152	1K5 5% ¼W Carbon	Mullard	CR25	-
R76	000 473	47K 5% ¼W Carbon	Mullard	CR25	-
R77	000 104	100K 5% ¼W Carbon	Mullard	CR25	-
R78	000 682	6K8 5% ¼W Carbon	Mullard	CR25	-
R79	000 101	100R 5% ¼W Carbon	Mullard	CR25	-
R80	000 681	680R 5% ¼W Carbon	Mullard	CR25	1
R81	000 101	100R 5% ¼W Carbon	Mullard	CR25	-
R82	000 152	1K5 5% ¼W Carbon	Mullard	CR25	-
R83-R84	000 103	10K 5% ¼W Carbon	Mullard	CR25	-
R85	000 103	10K 5% ¼W Carbon	Mullard	CR25	-
R86	000 183	18K 5% ¼W Carbon	Mullard	CR25	-
R87	000 682	6K8 5% ¼W Carbon	Mullard	CR25	-
R88	000 104	100K 5% ¼W Carbon	Mullard	CR25	-
R89	000 104	100K 5% ¼W Carbon	Mullard	CR25	-
R90	000 682	6K8 5% ¼W Carbon	Mullard	CR25	-
R91	000 101	100R 5% ¼W Carbon	Mullard	CR25	-
R92	000 102	1K 5% ¼W Carbon	Mullard	CR25	-
R93	000 471	470R 5% ¼W Carbon	Mullard	CR25	1
R94	000 101	100R 5% ¼W Carbon	Mullard	CR25	-
R95	000 103	10K 5% ¼W Carbon	Mullard	CR25	-
R96	000 103	10K 5% ¼W Carbon	Mullard	CR25	-
R97	000 102	1K 5% ¼W Carbon	Mullard	CR25	-

NOTES.

DATE. 15/08/74	datron ELECTRONICS LTD.
DRAWN BY.	TITLE 1041 AC CONVERTOR
CHECK	
NEXT DRAWING Rev 2	DRAWING NUMBER 400 037
	SHEET 5 OF ~~12~~

	PART No.		MANUFACTURER	PART No.	Per Assy.
R98	063 205	2M ⅜" Cer Pot	Beckman	72P	3
R99	000 476	47M 10% ¼W Carbon	Allan Bradley (Morganite)	CB10	3
R100		FSV (4M7 - 10M)	Mullard	CR25	1 of Pair
R101		FSV (4M7 - 10M)	Mullard	CR25	
R102	000 103	10K 5% ¼W Carbon	Mullard	CR25	-
R103	000 104	100K 5% ¼W Carbon	Mullard	CR25	-
R104	000 105	1M 5% ¼W Carbon	Mullard	CR25	-
R105	000 104	100K 5% ¼W Carbon	Mullard	CR25	-
R106	000 105	1M 5% ¼W Carbon	Mullard	CR25	-
R107	000 105	1M 5% ¼W Carbon	Mullard	CR25	-
R108	000 223	22K 5% ¼W Carbon	Mullard	CR25	2
R109	063 205	2M ⅜" Cer Pot	Beckman	72P	-
R110	000 476	47M 10% ¼W Carbon	Allan Bradley (Morganite)	CB10	-
R111		FSV (1M5 - 10M)	Mullard	CR25	1 of Pair
R112		FSV (1M5 - 10M)	Mullard	CR25	
R113	000 223	22K 5% ¼W Carbon	Mullard	CR25	-
R114	000 222	2K2 5% ¼W Carbon	Mullard	CR25	-
R115	063 205	2M ⅜" Cer Pot	Beckman	72P	-
R116	000 476	47M 10% ¼W Carbon	Allan Bradley	CB10	-
R117		FSV (1M5 - 10M)	Mullard	CR25	1 of Pair
R118		FSV (1M5 - 10M)	Mullard	CR25	
R119	000 104	100K 5% ¼W Carbon	Mullard	CR25	-
R120	000 334	330K 5% ¼W Carbon	Mullard	CR25	1

NOTES.

DATE. 15/08/74	datron ELECTRONICS LTD.
DRAWN BY.	TITLE 1041 AC CONVERTOR
CHECK	
NEXT DRAWING	DRAWING NUMBER 400 037
Rev 2	SHEET 6 OF ~~12~~

R121	000 683	68K 5% ¼W Carbon	Mullard	CR25	-
R122	000 105	1M 5% ¼W Carbon	Mullard	CR25	-
R123	000 105	1M 5% ¼W Carbon	Mullard	CR25	-
R124	000 336	33M 10% ¼W Carbon	Allan Bradley	CB10	2
R125		FSV (0 - 47K) Carbon	Mullard	CR25	
R126	000 156	15M 10% ¼W Carbon	Allan Bradley	CB10	1
R127	000 683	68K 5% ¼W Carbon	Mullard	CR25	-
R128		FSV (1M - 1M8)	Mullard	CR25	
R129	000 336	33M 10% ¼W Carbon	Allan Bradley	CB10	-

NOTES.

DATE. 15/08/74	datron ELECTRONICS LTD.
DRAWN BY.	TITLE 1041 AC CONVERTOR (01)
CHECK	
NEXT DRAWING	
Rev 2	DRAWING NUMBER 400 037
	SHEET 7 OF 12

	PART No.		MANUFACTURER	PART No.	Per Assy.
C1	130 006	82pF 5% 160V PS	Suflex		1
C2	130 017	27pF ±1pF 630V PS	Suflex		2
C3	130 017	27pF ±1pF 630V PS	Suflex		-
C4	110 012	150pF 10% 400V PY	Wima	Tropyfol F	3
C5	* 130 026	27pF ±1pF 160V PS	Suflex		1 *
C6	140 008	10pF PTFE Trimmer	Jackson	VPC Tetfer	3
C7	130 013	18pF ±1pF 160V PS	Suflex		3
C8	120 001	.22mF 10% 1KV Polycarb	Facel		1
C9	* 130 027	1100pF 25% 63V PS	Suflex		1 *
C10	110 012	150pF 10% 400V PY	Wima	Tropyfol F	-
C11	130 025	22pF ±1pF 160V PS	Suflex		1
C12	130 013	18pF ±1pF 160V PS	Suflex		-
C13	140 008	10pF PTFE Trimmer	Jackson	VPC Tetfer	-
C10	130 024	110pF 2.5% 160V PS	Suflex		1
C15	140 007	15pF PTFE Trimmer	Jackson	VPC Tetfer	2
C16	130 014	33pF ±1pF 160V PS	Suflex		1
C17	130 013	18pF ±1pF 160V PS	Suflex		-
C18	140 008	10pF PTFE Trimmer	Jackson	VPC Tetfer	-
C19	130 016	130pF 25% 160V PS	Suflex		1
C20	140 007	15pF PTFE Trimmer	Jackson	VPC Tetfer	-
C21	130 012	1200pF 2.5% 63V PS	Suflex		1
C22	150 003	47mF 6.3V Tant Bead	Union Carbide	K47E6	4
C23	150 003	47mF 6.3V Tant Bead	Union Carbide	K47E6	-

NOTES.

* C9 and C5 may be 1200pF (130 012) and 22pF (130 025) respectively if 1100pF is unavailable.

DATE. 15/08/74	datron ELECTRONICS LTD.
DRAWN BY.	TITLE 1041 AC CONVERTOR
CHECK	
NEXT DRAWING	
Rev 2	DRAWING NUMBER 400 037 SHEET 8 OF 12

C24	110 012	150pF 10% 400V PY	Wima	Tropyfol F	-
C25	102 102	1KpF 500V Cer Disc	Erie	831	1
C26	102 221	220pF 500V Cer Disc	Erie	831	3
C27	102 221	220pF 500V Cer Disc	Erie	831	-
C28	101 103	.01mF 250V Cer Disc	Erie	801	6
C29	150 002	10mF 16V Tant Bead	Union Carbide	K10E16	4
C30	101 103	.01mF 250V Cer Disc	Erie	801	-
C31	101 103	.01mF 250V Cer Disc	Erie	801	-
C32	101 103	.01mF 250V Cer Disc	Erie	801	-
C33	102 101	100pF 500V Cer Disc	Erie	801	6
C34	102 101	100pF 500V Cer Disc	Erie	801	-
C35	102 101	100pF 500V Cer Disc	Erie	801	-
C36	102 101	100pF 500V Cer Disc	Erie	801	-
C37	150 002	10mF 16V Tant Bead	Union Carbide	K10E16	-
C38	150 002	10mF 16V Tant Bead	Union Carbide	K10E16	-
C39	101 103	.01mF 250V Cer Disc	Erie	801	-
C40	101 103	.01mF 250V Cer Disc	Erie	801	-
C41	120 010	1.5mF 10% 160V PC	Advance Filmcap	CMR25A	1
C42	* 110 018	6.8mF 10% 63V PY	Advance Filmcap	MD45A	1
C43	* 110 019	4.7mF 10% 63V PY	Advance Filmcap	MD40A	1
C44	110 009	1.0mF 10% 100V PY	Wima	MKS	1
C45	102 101	100pF 500V Cer Disc	Erie	801	-
C46	102 101	100pF 500V Cer Disc	Erie	801	-

NOTES.

* Issue 2 PCB uses 10mF (110 001) and 6.8mF (110 018) respectively.

DATE. 15/08/74	datron ELECTRONICS LTD.
DRAWN BY.	TITLE 1041 AC CONVERTOR
CHECK	
NEXT DRAWING Rev 2	DRAWING NUMBER 400 037
	SHEET 9 OF 12

	PART No.		MANUFACTURER	PART No.	Per Assy.
C47	102 220	22pF 500V Cer Disc	Erie	831	1
C48	102 228	2.2pF 500V Cer Disc	Erie	831	1
C49	150 010	.33mF 35V Tant Bead	Union Carbide	KR33E35	1
C50	150 005	2.2mF 16V Tant Bead	Union Carbide	K2R2E16	1
C51	150 002	10mF 16V Tant Bead	Union Carbide	K10E16	-
C52	150 001	22mF 16V Tant Bead	Union Carbide	K10E16	4
C53	150 001	22mF 16V Tant Bead	Union Carbide	K10E16	-
C54	102 221	220pF 500V Cer Disc	Erie	801	-
C55-C56- C59	*	Twisted Wire Pair			*
C57-C58	150 001	22mF/16V Tant Bead	Union Carbide	K22E16	-
CR1	Not Used				
CR2-CR13	200 001	Diode Sil GP Switch		IN4148	20
CR14	210 056	Diode Zener 5.6V		BZY88C5V6	1
CR15-CR16	210 100	Diode Zener 10V		BZY88C10V	2
CR17	Not Used				
CR18-CR21	200 001	Diode Sil GP Switch		IN4148	-
CR22-CR24	220 007	Diode Schottky	HP	5082-2800	3
CR25-CR28	200 001	Diode Sil GP Switch		IN4148	-
CR29-CR32	200 008	Diode Sil Low Leak		IN458A	4

NOTES.

* Use very stiff insulated wire about ½" long - guage approx. .8mm.
May use bare wire with insulating sleeving.

DATE. 15/08/74	datron ELECTRONICS LTD.
DRAWN BY.	TITLE 1041 AC CONVERTOR
CHECK	
NEXT DRAWING	
Rev 2	DRAWING NUMBER 400 037 SHEET 10 OF ~~12~~

Q1	240 001	Sil N.P.N. Hi HFE GP		BC184K	5
Q2	230 007	N Fet GP Switch	Teledyne	U1899E	5
Q3	230 007	N Fet GP Switch		U1899E	-
Q4	230 007	N Fet GP Switch		U1899E	-
Q5	230 007	N Fet GP Switch		U1899E	-
Q6a, Q6b	239 014	Sil Monolithic Dual Fet		2N3956	1
Q7	240 00	Sil N.P.N. Hi HFE GP		BC184KC	1
Q8	240 001	Sil N.P.N. GP		BC184K	-
Q9	230 007	N Fet GP Switch	Teledyne	U1899E	-
Q10	250 004	Sil P.N.P. HF GP		2N3906	6
Q11	240 001	Sil N.P.N. GP		BC184K	-
Q12	250 004	Sil P.N.P. HF GP		2N3906	-
Q13	250 004	Sil P.N.P. HF GP		2N3906	-
Q14	240 006	Sil N.P.N. HG GP		2N3904	2
Q15	240 001	Sil N.P.N. Hi HFE GP		BC184K	-
Q16	230 002	N Fet GP	Teledyne	U1994E	2
Q17	250 004	Sil P.N.P. HF GP		2N3906	-
Q18	250 004	Sil P.N.P. HF GP		2N3906	-
Q19	240 006	Sil N.P.N. HF GP		2N3904	-
Q20	250 004	Sil P.N.P. HF GP		2N3906	-
Q21	230 002	N Fet GP	Teledyne	U1994E	-
Q22	240 001	Sil N.P.N. Hi HFE GP		BC184K	-

NOTES.

DATE. 15/08/74	datron ELECTRONICS LTD.
DRAWN BY.	TITLE 1041 AC CONVERTOR
CHECK	
NEXT DRAWING	
Rev 2	DRAWING NUMBER 400 037 SHEET 11 OF 12

	PART No.		MANUFACTURER	PART No.	Per Assy.
M1	260 009	Wide Band Op Amp	National	LM318H	1
M2	290 009	Precision GP Op Amp	National/Datron	LM301A H Sel Black	2
M3	290 009	Precision GP Op Amp	National	LM301A H Sel Black	-
M4	(2) 290 010	Precision GP Op Amp	National	LM301A H	2
M5	(2) 290 010	Precision GP Op Amp	National	LM301A H	-
M6	290 002	RMS Module Kit	Datron	290 002	1
K1 Rly Assy	400 072	AC Relay Assy		(3)	1
K2 Rly Assy	400 073	Attenuator Rly Assy		(3)	1
	410 006	Printed Circuit Board		410 006 - 3	1
	604 004	Pin Plugs	Amp	1 - 163749 - 2 (1)	1
	612 005	Stand-Off Rivet M3	Harwin		4
	620 001	Cloverleaft Bush	Sealectro		6
	620 003	Rivet Solder Terminal	Harwin	H2105A	4
	602 001	FSV Terminals	Molex	02 - 04 - 1875	30
	630 003	P Clip $\frac{1}{4}$"			1
	611 004	M3 x 6 Pozipan	GKN		2
	613 007	M3 Plain Washer			2
	615 002	M3 Hex Nut			2
	613 005	M3 Shkprf Washer			2

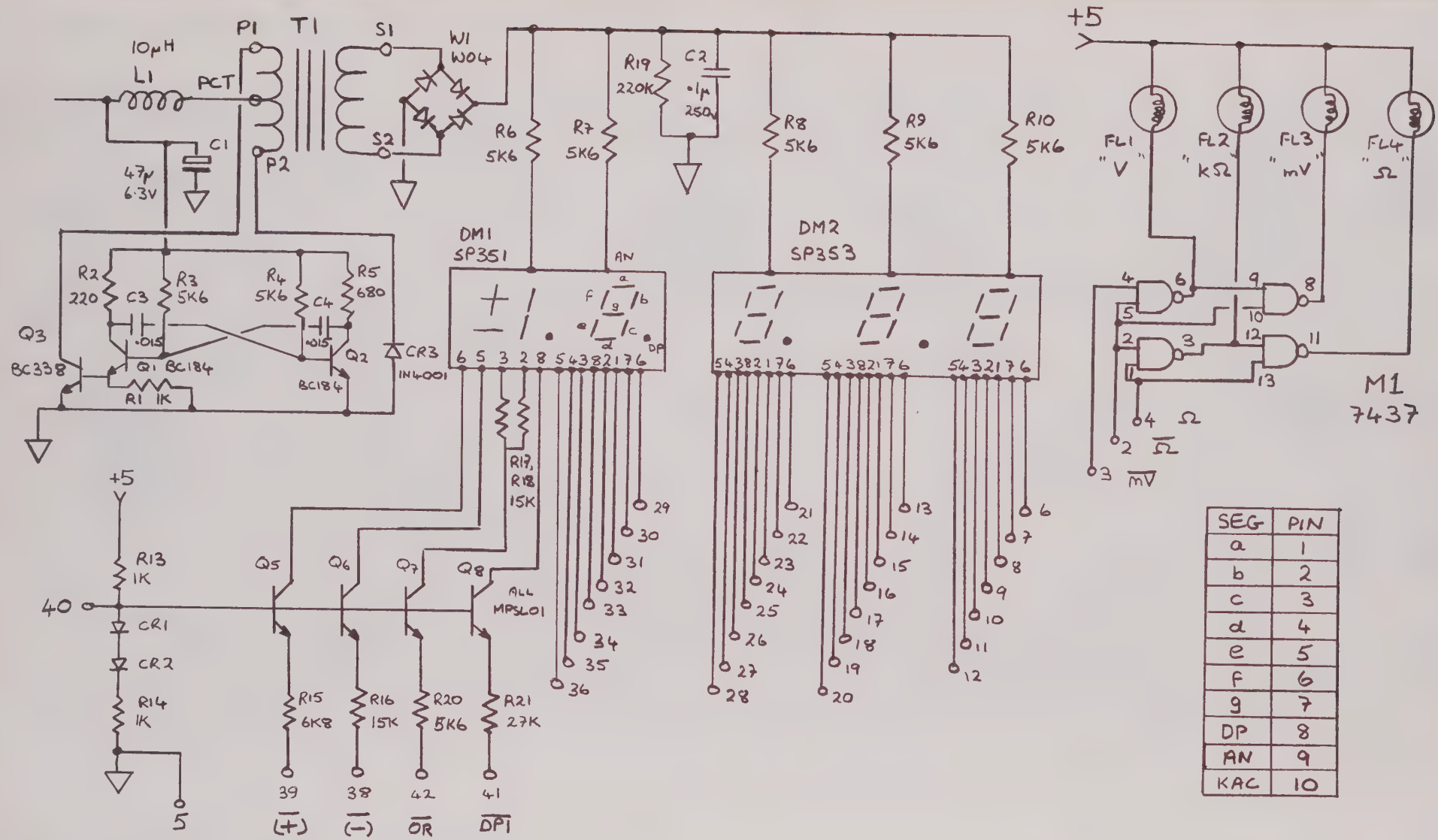
NOTES.

(1) Strip of 13 pins

(2) May use 260 001 or 290 009

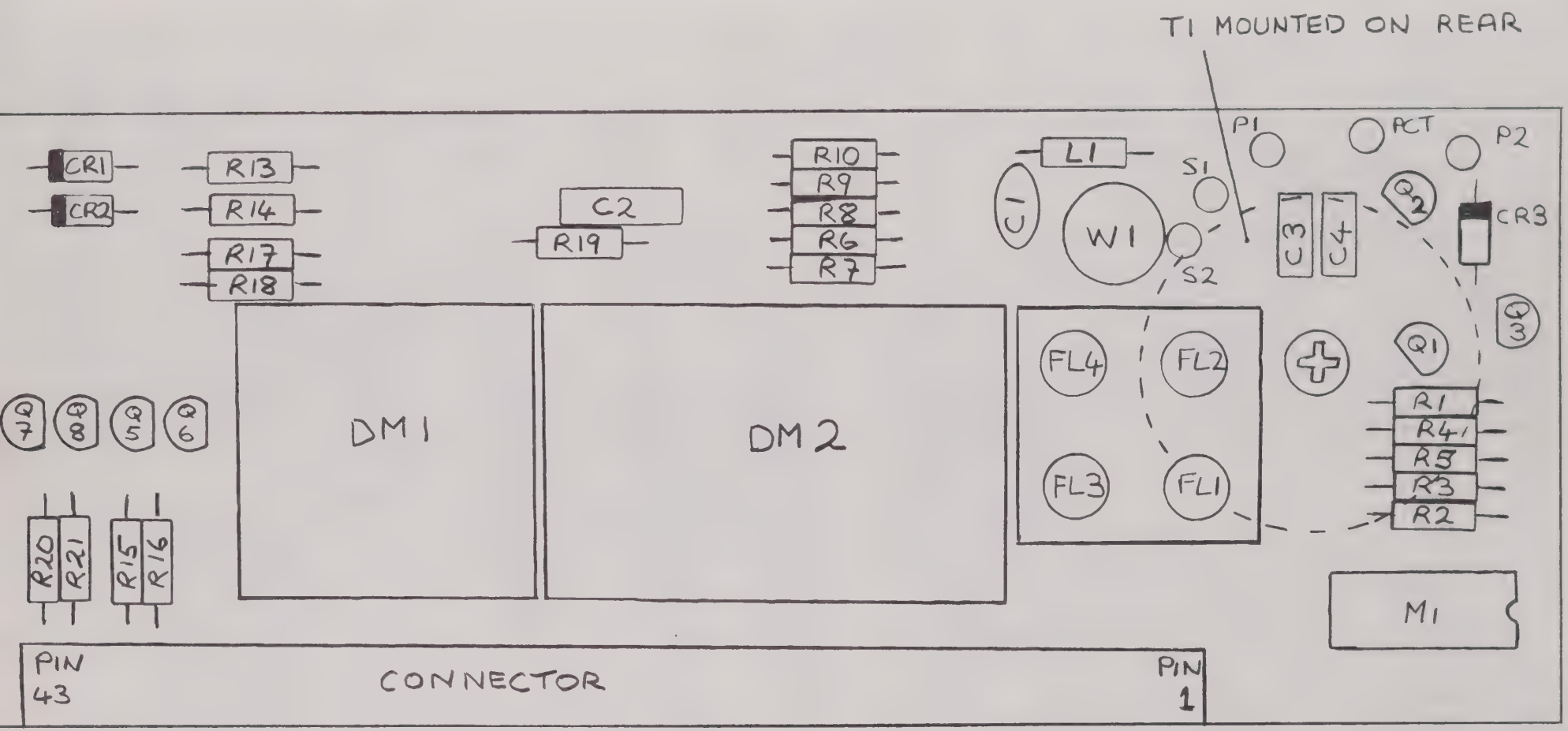
(3) Each relay Assy uses 1 R10-E1-62-Q5.8K (or S3.2K)

DATE. 15/08/74	datron ELECTRONICS LTD.
DRAWN BY.	TITLE 1041 AC CONVERTOR
CHECK	
NEXT DRAWING	
Rev 2	DRAWING NUMBER 400 037 SHEET 12 OF 12

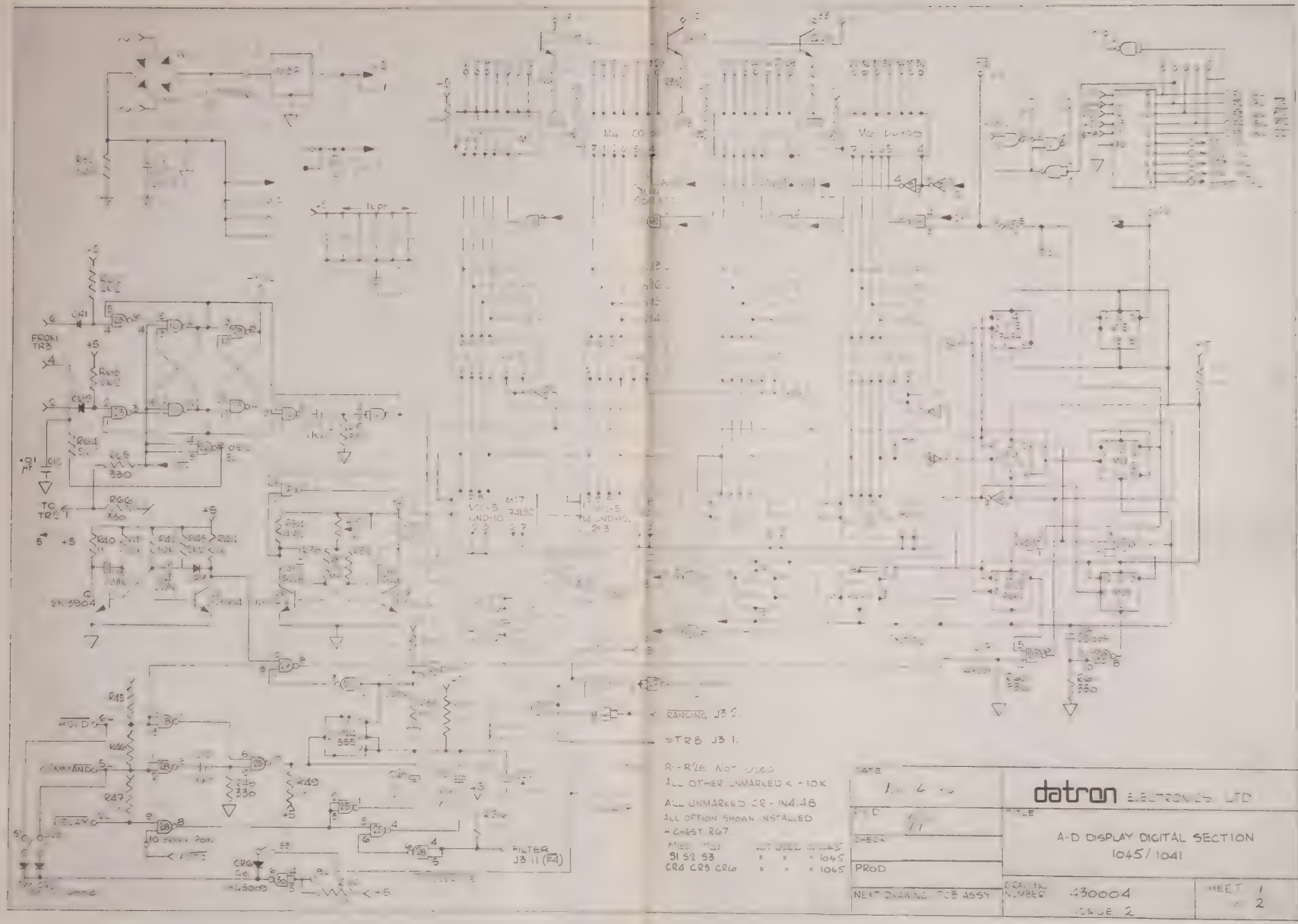


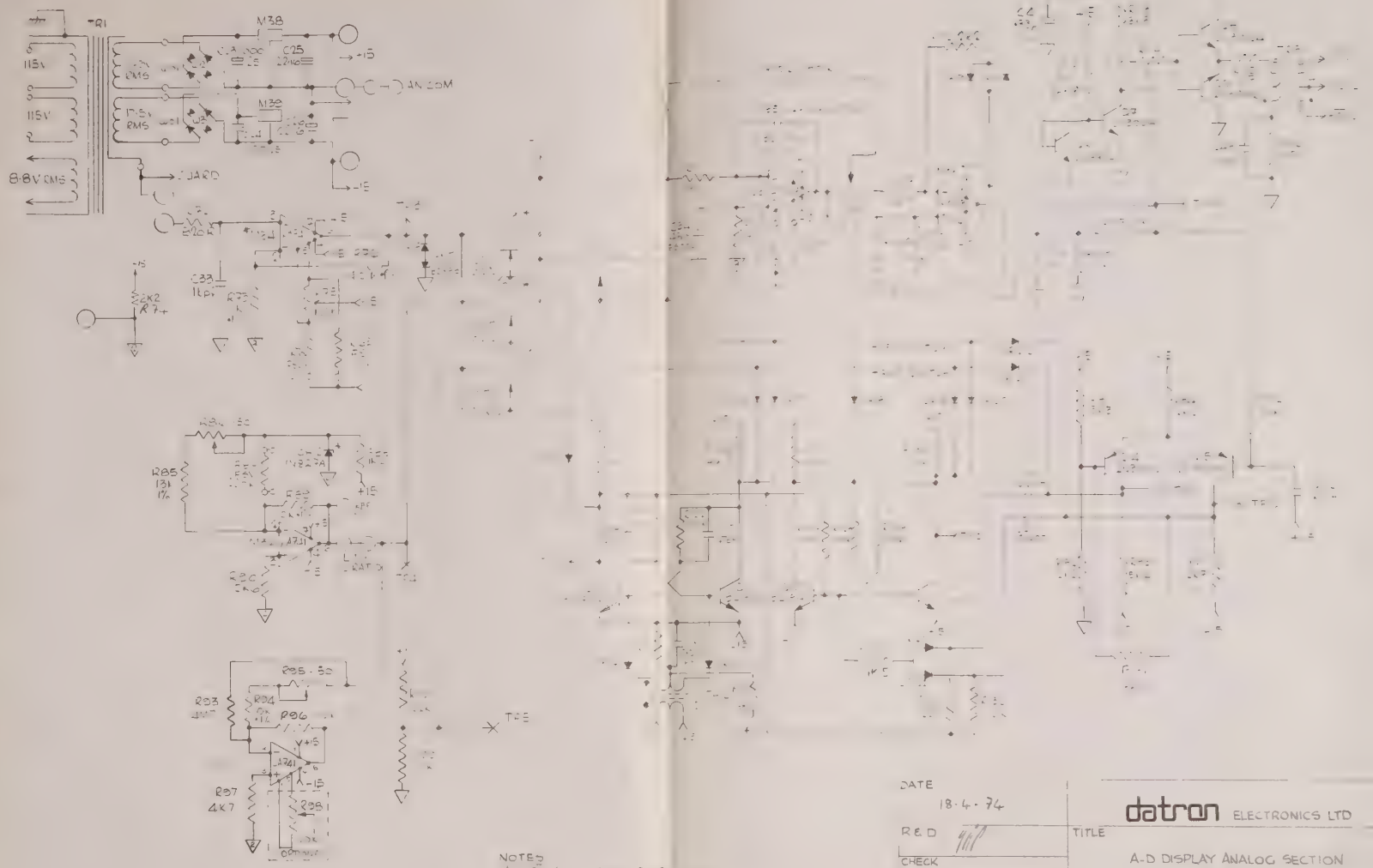
SEG	PIN
a	1
b	2
c	3
d	4
e	5
f	6
g	7
DP	8
AN	9
KAC	10

DATE. 20-11-74	datron ELECTRONICS LTD.
DRAWN BY. GRP	TITLE 1041 DISPLAY SCHEMATIC
CHECK	
NEXT DRAWING 400026	DRAWING NUMBER 430007
REV 2	SHEET 1 OF 1



DATE. 20-11-74	datron ELECTRONICS LTD.
DRAWN BY. IRP	TITLE 1041 DISPLAY ASSY.
CHECK	
NEXT DRAWING	
REV 2	DRAWING NUMBER 400026 SHEET 1 OF

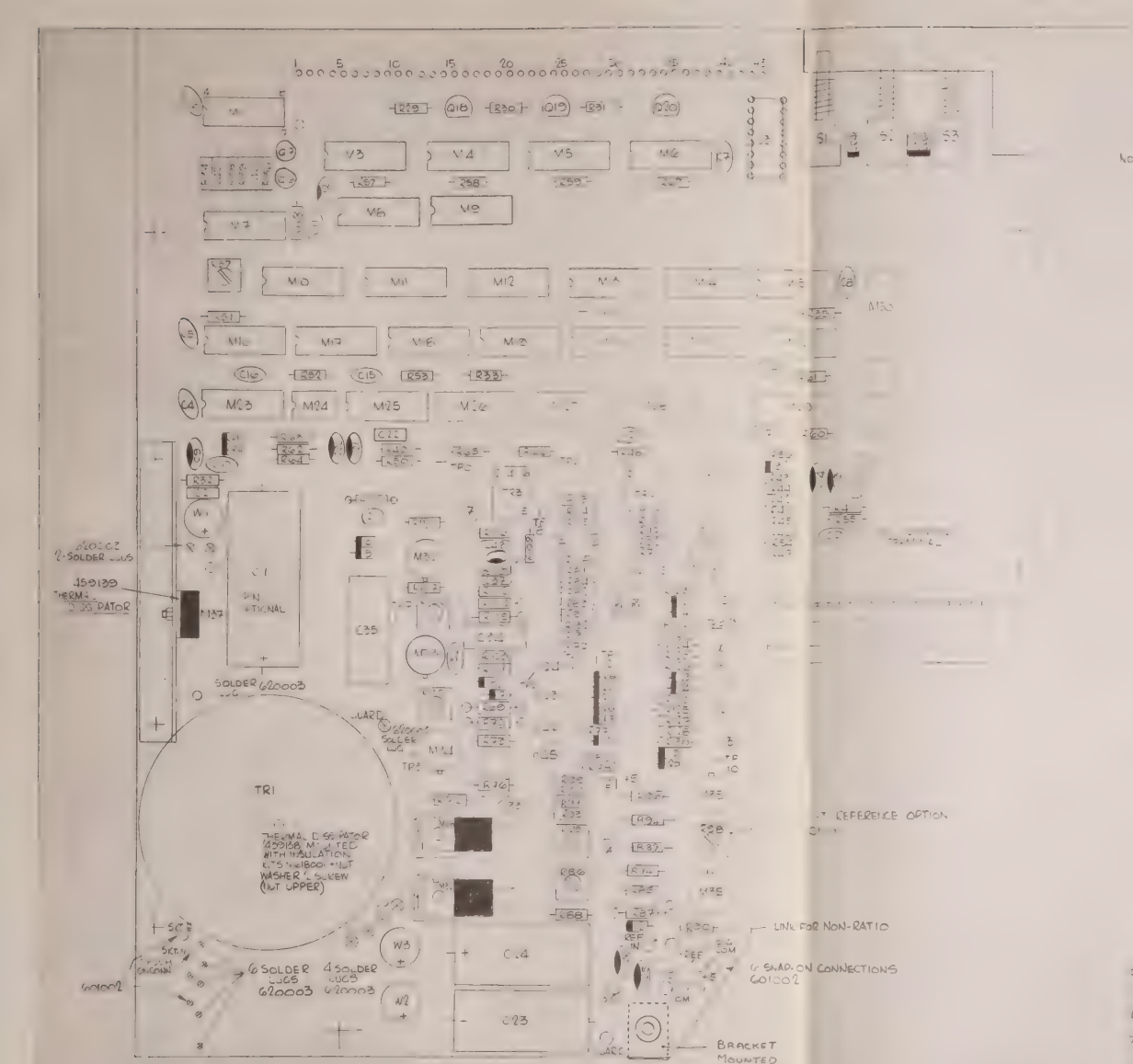

FROM TR3
+5
R44
330
TO TR2
2N3904
R45
R46
330
R40
R41
R42
R43
R47
R48
R49
330
HOLD
RANGING
STRB
FILTER
J3 11 (F4)
CR2
CR3
CR6
4300B
RANGING J3 2.
STRB J3 1.
R-R/LE NOT USED
ALL OTHER UNMARKED R - 10K
ALL UNMARKED CR - IN4148
ALL OPTION SHOWN INSTALLED
H CREST R67.
DATE
DRAWN
CHECK
PROD
NEXT DRAWING PCB ASSY
datron ELECTRONICS LTD
TITLE
A-D DISPLAY DIGITAL SECTION
1045/1041
DRAWING NUMBER
430004
ISSUE 2
SHEET 1
OF 2



NOTES
ASTERISK INDICATES DATRON SELECTED COMPONENTS

ALL DIODES N4148 UNLESS NOTED OTHERWISE

DATE 18-4-74	datron ELECTRONICS LTD	
R.E.D	TITLE	
CHECK	A-D DISPLAY ANALOG SECTION 1045/1041.	
PROD.		
NEXT DRG PCB ASSY 400109/120	DRAWING NUMBER 430004 ISSUE 2	SHEET 2 OF 2


TRI
THERMAL DISSIPATOR 459138 MOUNTED WITH INSULATION KITS No 18001 + NUT WASHER & SOLDER (NUT UPPER)
6 SOLDER LUGS 620003
4 SOLDER LUGS 620003
2 SOLDER LUGS 620002
459139 THERMISTOR
PIN OPTIONAL
SOLDER LUG 620003
LINK FOR NON-RATIO
6 SNAP-ON CONNECTIONS 601002
BRACKET MOUNTED UNDERSIDE

NOTES:

1. CONNECTOR TERMINALS MUST BE PREFORMED AS BELOW BEFORE SOLDERING.

2. INSTALL IC CONNECTOR STRIPS FOR ALL DUAL-IN-LINE TOGETHER WITH NYLON CARRIERS OR ALTERNATIVES
3. TERMINALS SHOWN ON RESISTOR LEGS (E.G. R87) ARE COMPONENT MOUNTING PINS.
4. TERMINALS MARKED AS SOLDER LUGS ARE FOR SOLDERED WIRE CONNECTIONS.

ALL OTHER TERMINALS ARE FOR SNAP-ON WIRE CONNECTIONS

TPS ARE BENT LOOPS OF WIRE AS BELOW

- ⊘ DENOTES SOLDER LUG CONNECTION TO TRANSFORMER
- C7 AND C38 SHOULD BE MOUNTED AS LOW AS POSSIBLE ON P.C.B

DATE

DRAWN BY

CHECK

APP'D DRAWING

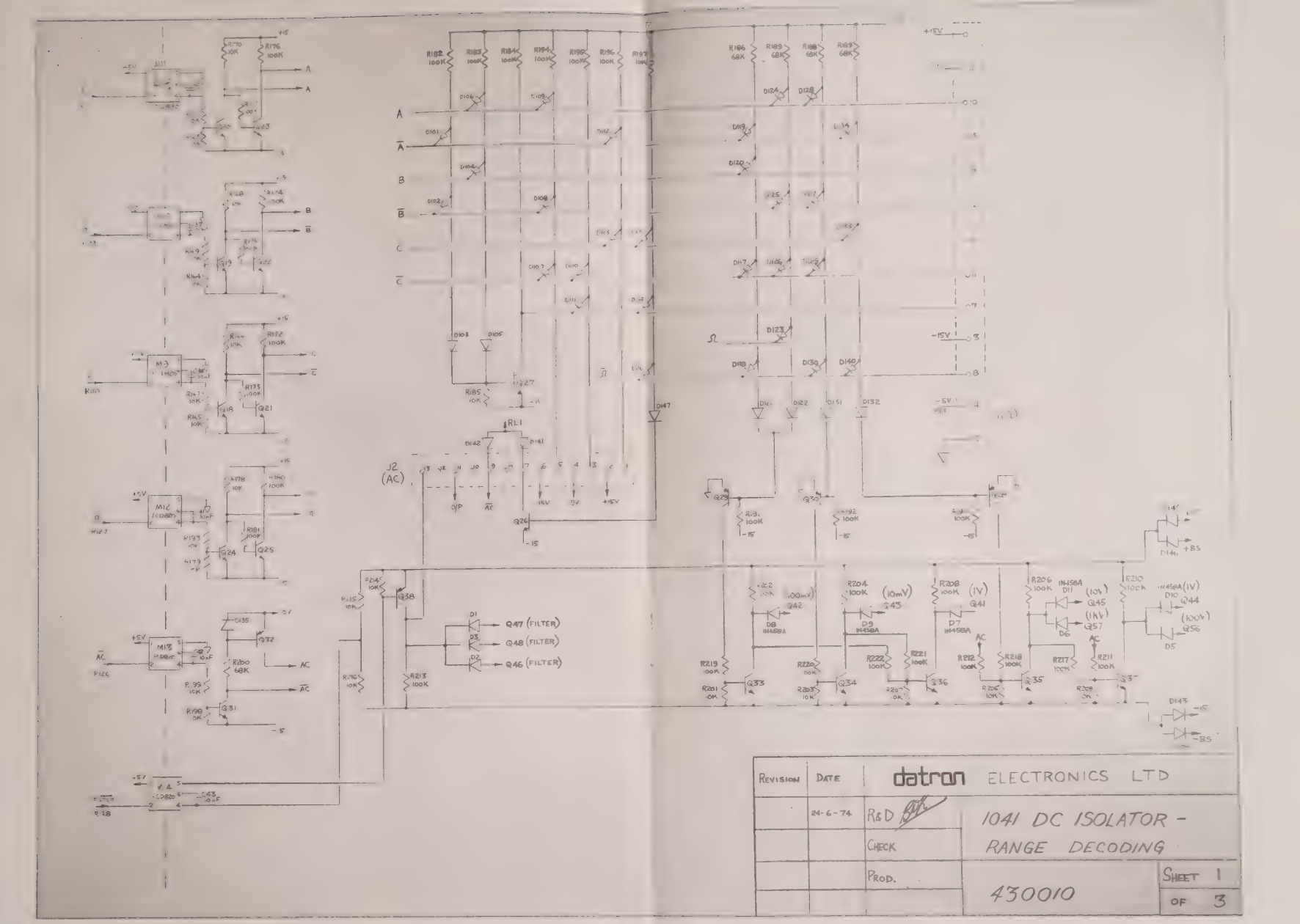
datron ELECTRONICS LTD

TITLE

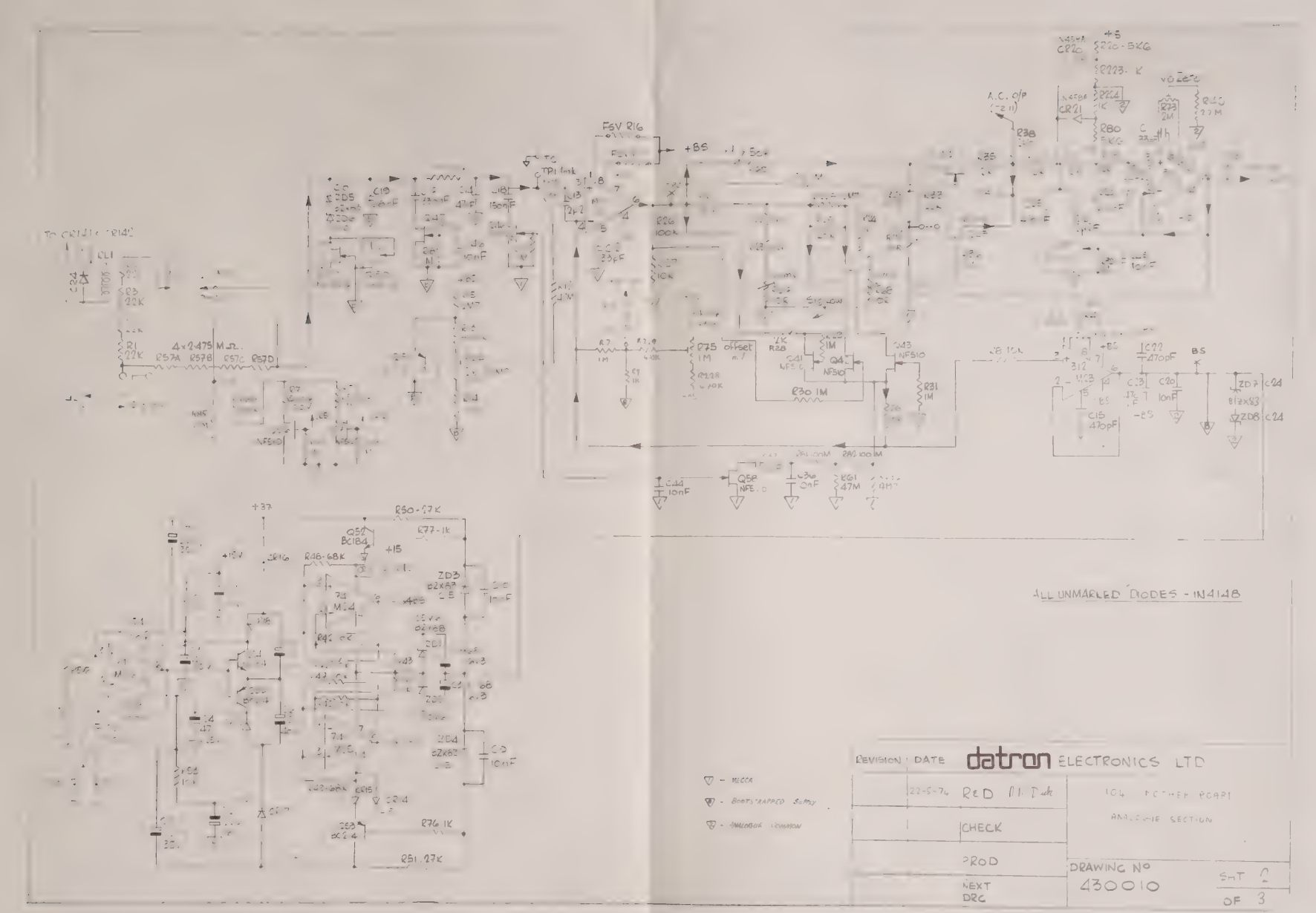
ANALOG TO DIGITAL COMERTER
·041.

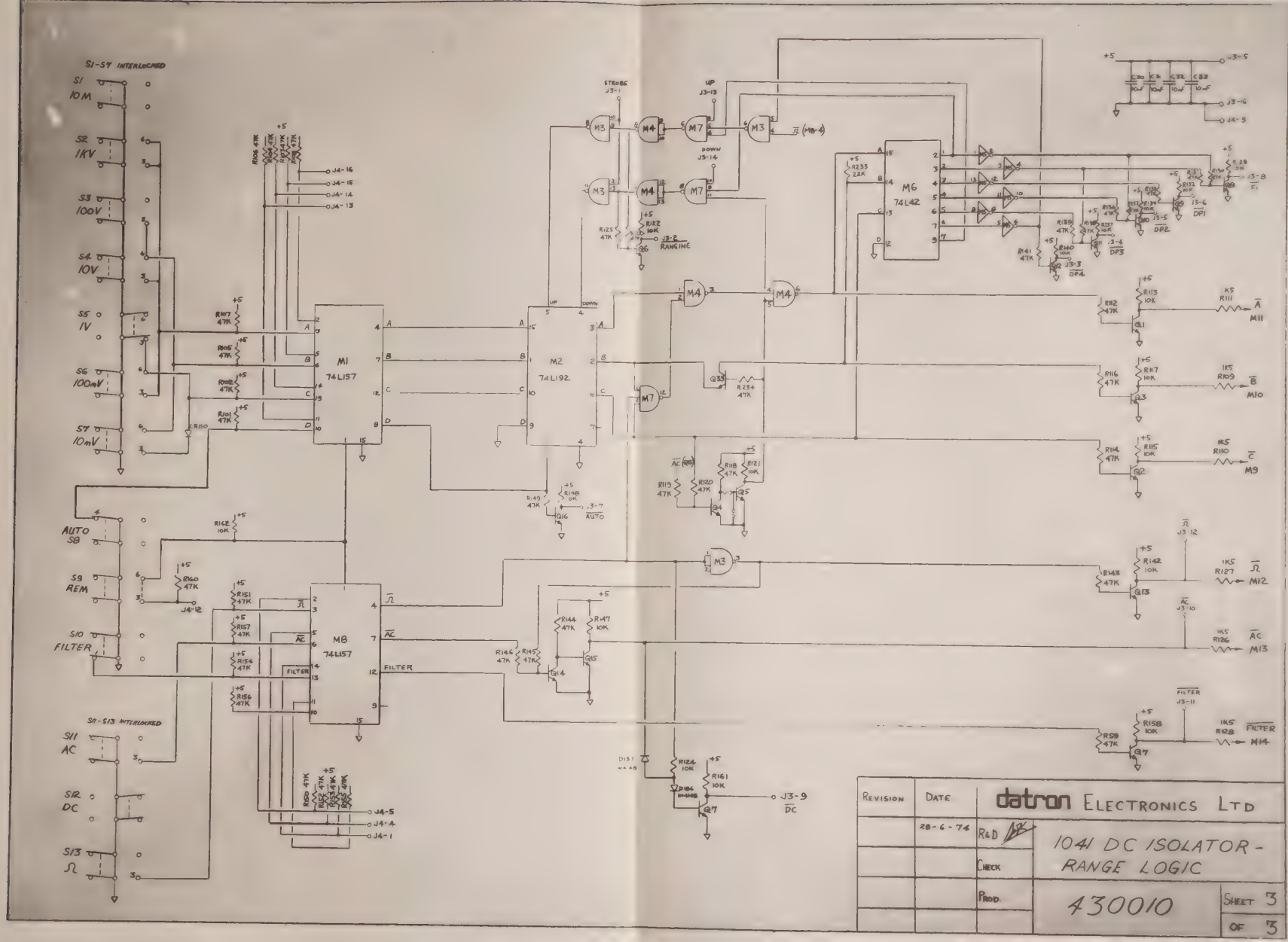
DRAWING NUMBER 100120A

SHEET 1 OF 1



Revision	Date	datron ELECTRONICS LTD	
	24-6-74	R&D	1041 DC ISOLATOR - RANGE DECODING
		Check	
		Prod.	430010
			Sheet 1 of 3


ALL UNMARKED DIODES - IN4148
∇ - MECCA
∇ - BOOTSTRAPPED SUPPLY
∇ - ANALOGUE VERSION
REVISION : DATE
22-5-74 RED
CHECK
PROD
NEXT DRG
datron ELECTRONICS LTD
ICL POWER BOARD
ANALOGUE SECTION
DRAWING Nº 430010
SHT 2 OF 3

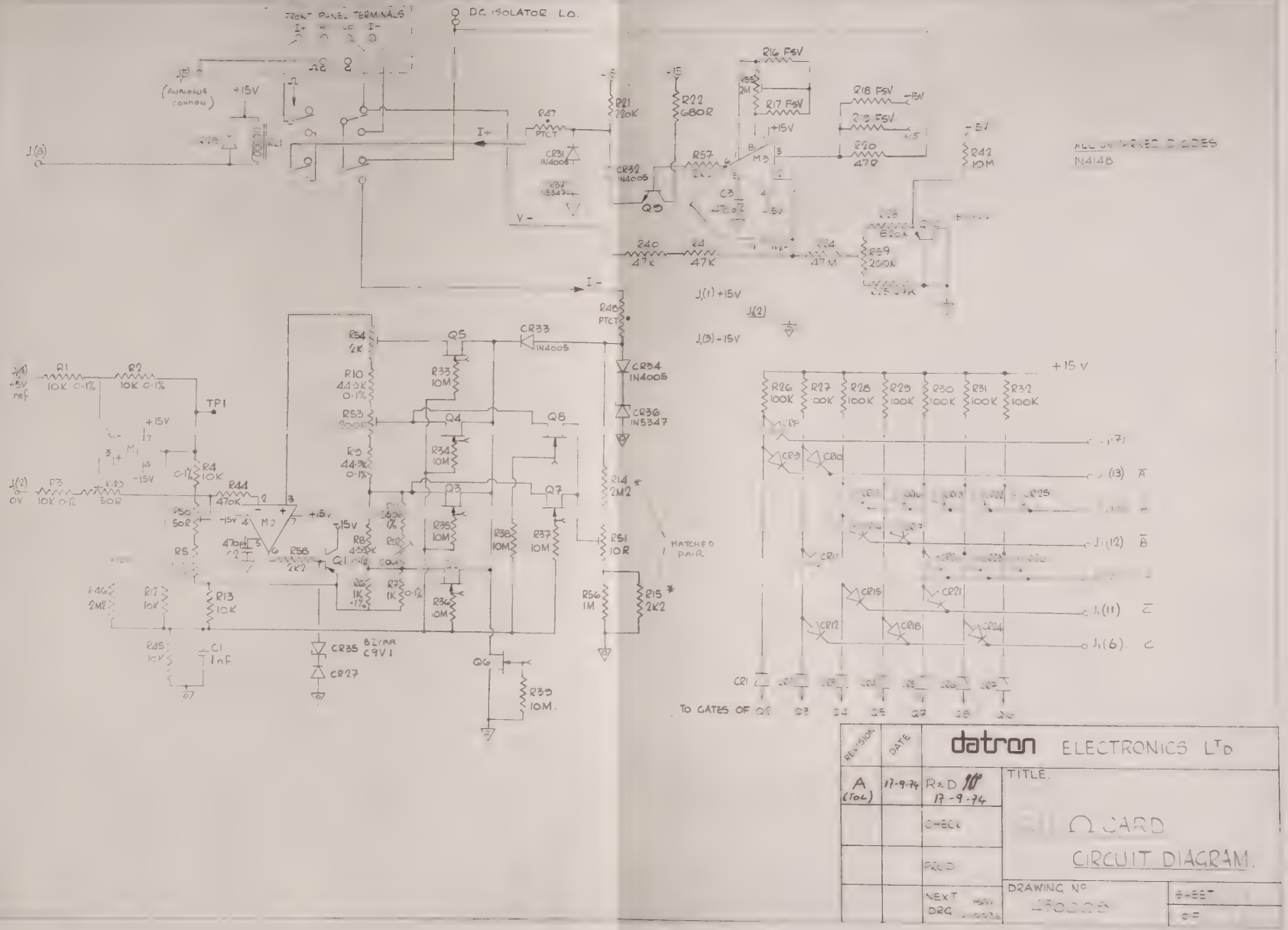


REVISION	DATE	datron ELECTRONICS LTD
	28-6-74 R&D	1041 DC ISOLATOR - RANGE LOGIC
	CHECK	
	PROD.	430010 SHEET 3 OF 3

REVISION	DATE	datran ELECTRONICS LTD
	30-4-74	R&D
1051 COMPATIBILITY	19-10-74	CHECK
		PROD.
		NEXT DRG.

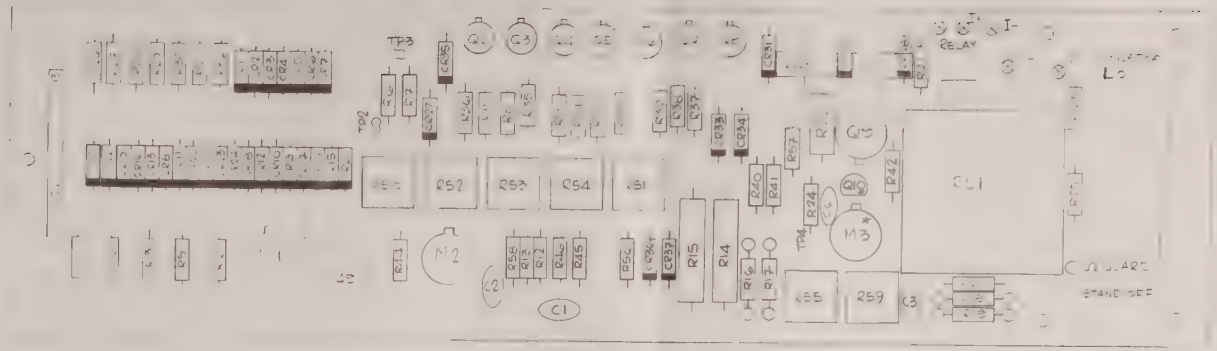
DRAWING N° 400035

SHEET 1 OF 1



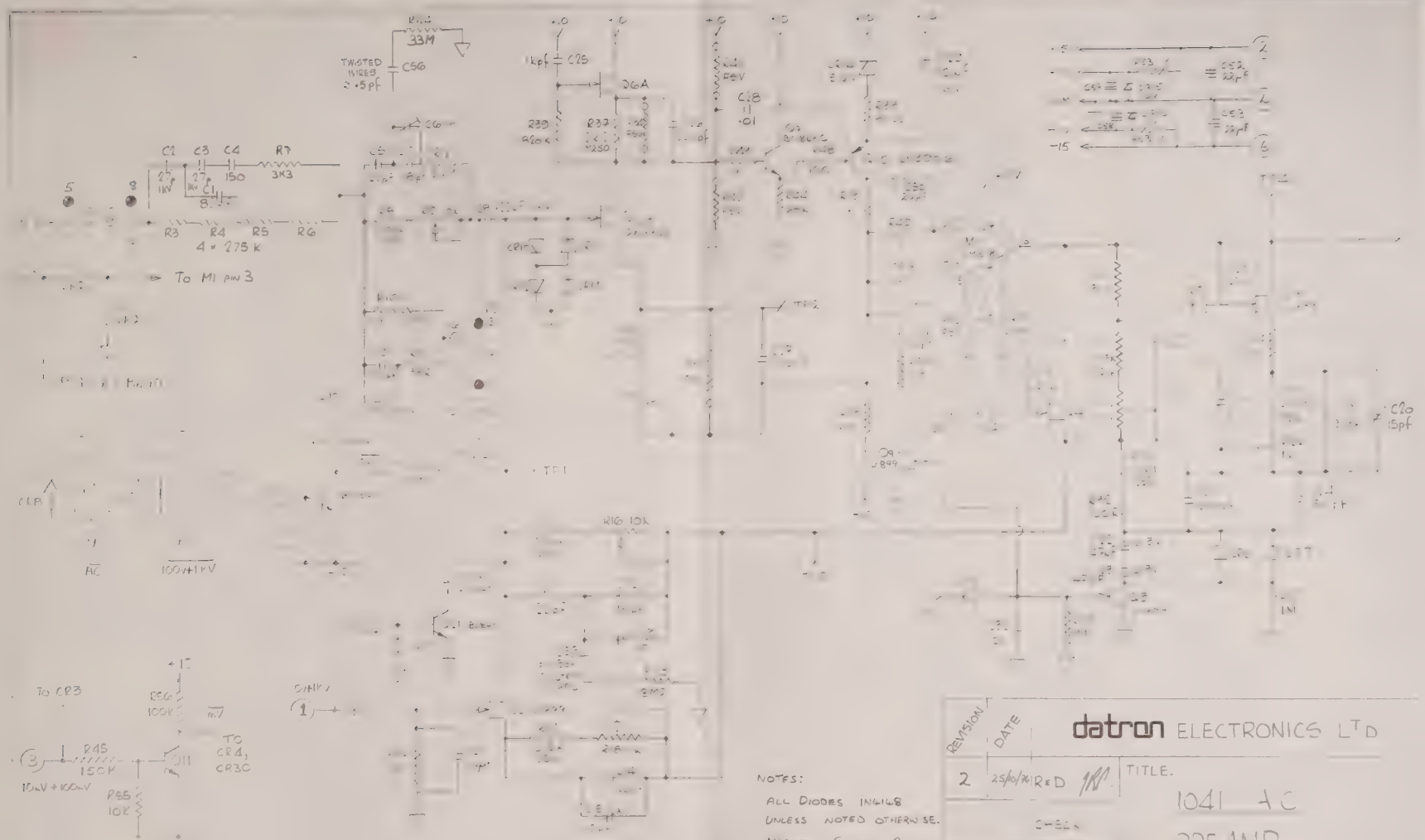
ALL DIODES IN4148

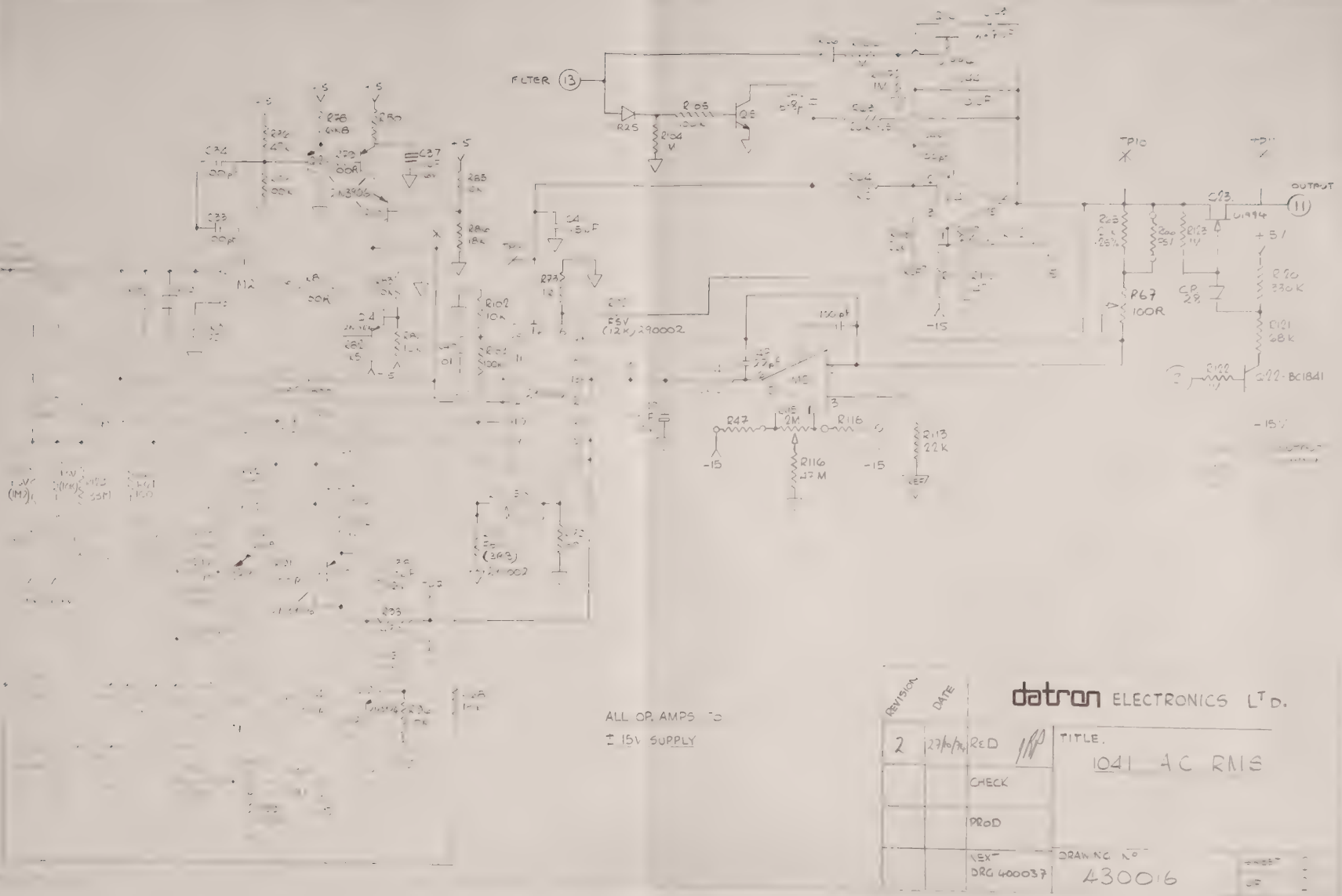
REVISION	DATE		
A (TOL)	17-9-74	R&D 17-9-74	datron ELECTRONICS LTD
		CHECK	TITLE: Ω CARD CIRCUIT DIAGRAM.
		PROD	
		NEXT DRG.	DRAWING No. 470008 SHEET OF



Q10 & M3 STUCK TOGETHER WITH CYANOCRYLATE

REVISION	DATE	datron ELECTRONICS LTD	
A (100)	9/9/76	R&D 19-9-76	TITLE
		CHECK	1041 Ω CARD PCB ASSEMBLY
		PROD	
		NEXT DRG	DRAWING No 400036
			SHEET 1 OF —


R16 33M
TWISTED WIRES 2·5pf
C56
1kpf C25
D6A
R39 R20K
R37 250
C18 .01
C1 C3 C4 R7
3K3
R3 R4 R5 R6
4 × 275 K
To M1 pin 3
TP1
TP2
C10 15pf
D9
C1A
AC
100V+1KV
R16 10K
TO CR3
R45 150K
10KV + 100V
R55 10K
-15
TO CR4, CR30
R26
NOTES:
ALL DIODES IN4148 UNLESS NOTED OTHERWISE.
NORMALLY CLOSED RELAY CONTACTS BLACK.
(M3) = CONNECTOR J2
REVISION
DATE
2
25/10/82
TITLE.
1041 AC PREAMP
CHECK
DRGD.
DRG Nº
430016.
SHEET
OF 2



REVISION	DATE		
2	27/10/81	RED	
		CHECK	
		PROD	
		NEXT DRG 400037	

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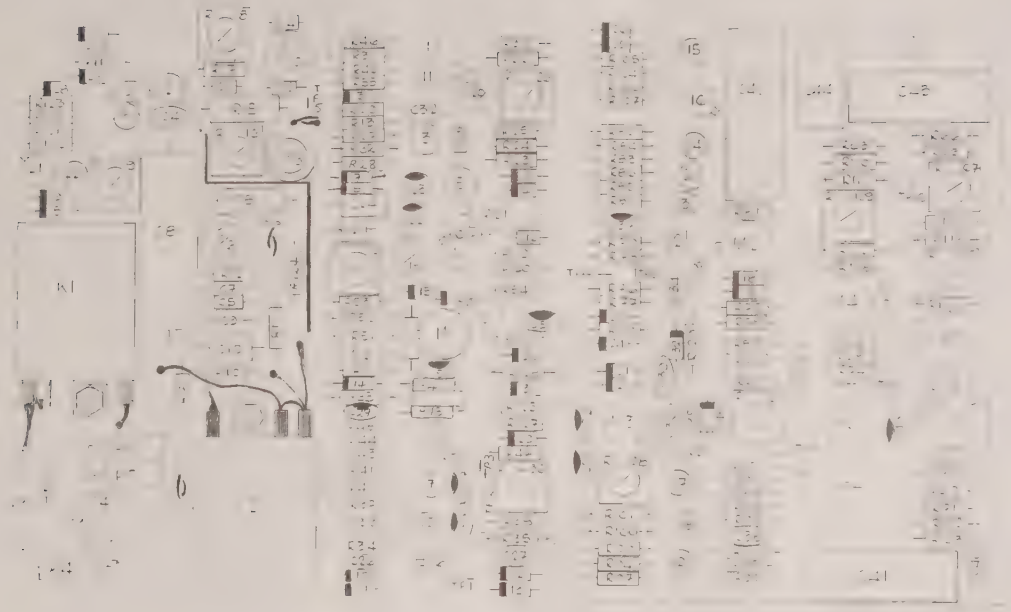
TITLE. 1041 AC RMS

DRAWING No. 430016

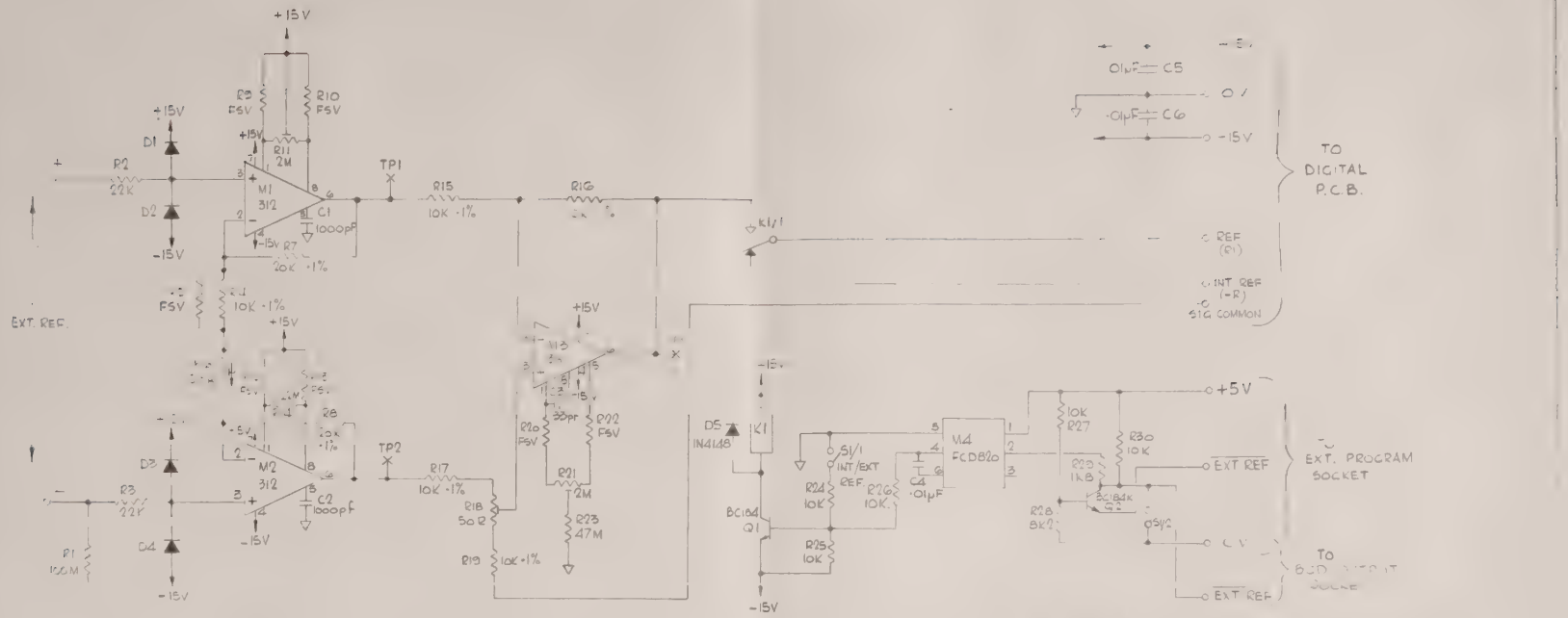
C55 - TWISTED PAIR
OF WIRES
(ie C56 & C59)



REV	DATE		
2	27/10/94	R&D	TITLE
		CHECK	AC (01 OPTION 1041)
		PROD	ASSEMBLY
		NEXT DRG	DRAWING No. 400037

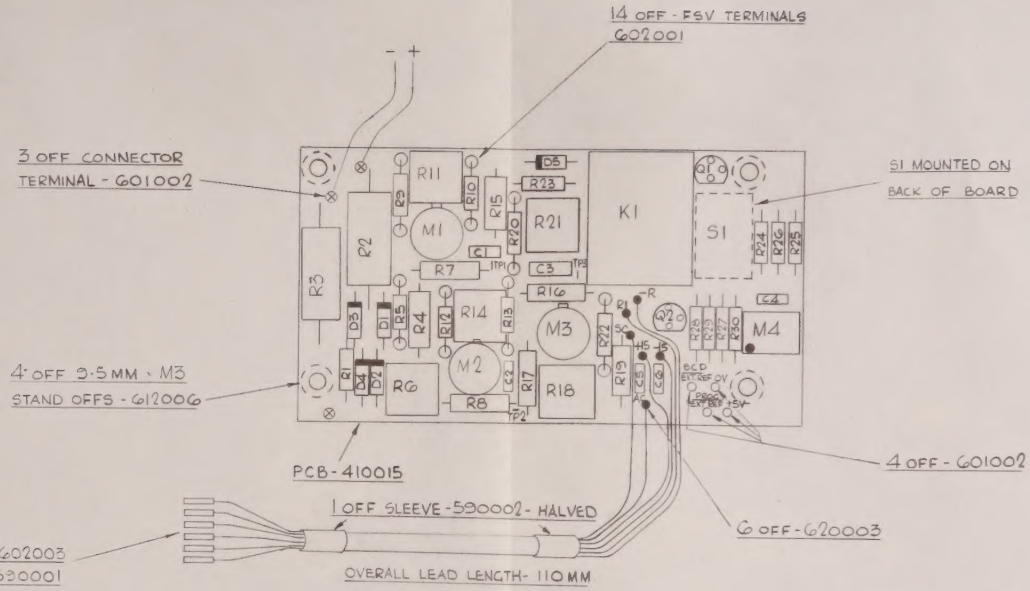
datron ELECTRONICS

SHEET 1 OF 2



datron ELECTRONICS LTD.

		DRG'D	TITLE. RATIO AMPLIFIER & SWITCHING
		CHECK	
		PROD	
		NEXT DRG	DRAWING No. 43001T



+15 V - RED
-15 V - BLUE
AC - GREEN
SC - GREY
-R - BROWN
R1 - WHITE

REVISION	DATE	datron ELECTRONICS LTD.		
		R&D.	TITLE	1041 RATIO AMP PCB LAYOUT & ASSEMBLY.
		CHECK		
		PROD.		
		NEXT DRG.	DRAWING Nº 400076	SHEET OF

Datron — John Pickering Tech. Director.

Alcon — Roger Connel

MP MASTER
MA30886